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GUIDE TO HIGH EXPLOSIVE FIELD TESTS WITH MILITARY APPLICATIONS—YIELDS OF 100 POUNDS OR MORE

General Electric Company —TEMPO
DASIAC
816 State Street
Santa Barbara, California 93102

March 1977

Final Report

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SUMMARY

This Guide presents concise summaries of operational information taken from published reports on high explosive (HE) field tests of 100 pounds or more. The summaries are arranged in alphabetical order by shot name and number. Each page includes, when the information is available to the author, the name of an event and the series of which it is a part; location; date and time of detonation; explosive source and charge configuration; geology of the site; meteorology at the time of burst; explosive weight*; test objective; and reference sources for such data. Details of the results of these HE events can be found in the referenced reports and the citations contained therein.

Radiological simulants tests, such as Roller Coaster and Clean Slate, are omitted. Also omitted are reports on simulation technology development experiments such as Sledge and Gas Bag (simulations with a detonable gaseous mixture), HEST (High Explosive Simulation Technique by which a simulated airblast is propagated across the test bed inside the test facility, thereby simulating a traveling airblast surrounding a large nuclear surface burst), DIHEST (Direct Induced High Explos ve Simulation Technique), DATEX (Dihest Array Test Experiments), and HANDEC (Hest and Dihest Environment Combined). In many of these tests, model silo structures were included at a given predicted level of overpressure to determine structural response; however, the tests were primarily simulation technique development tests. An exception to the exclusions is a limited reference to the 1974-1975 Hard Pan series using HEST cavity loading techniques to determine the response of buried facilities.

As finder tools for the convenience of the users of this Guide, four lists or indexes are included: alphabetical list to give a quick overview of events covered; alphabetical index by series to facilitate direct access to appropriate pages; a chronological index; and an index of events arranged by charge size. Also included is a table of TNT-equivalent explosive weight approximations.

*Note: For most events using an explosive other than TNT the weight given is actual weight of the explosive and not the TNT-equivalent weight. If equivalency weight is given, such fact is noted on the event page.

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ALPHABETICAL LISTING OF CITED HIGH EXPLOSIVE SHOTS

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AN/FO (1974, 5 shots)
AN/FO I,II,III (1969)
ANFO IV (1971)
ANFO V (1971)
Banshee I,II
Blast Directing Experiment (Dial Pack)
Blowdown (Dolphin)
Buckboard (13 shots)
pre-Buggy I, 1-6; A-D
pre-Buggy II
CAPSA and pre-CAPSA
Chase II,III,IV,V,VII,XVI-XXII
China Lake
Cowboy (15 shots)
Dial Pack
Diamond Mine HE
Diamond Ore IIA,IIB,IIC
pre-Dice Throw II
Dice Throw
Diode Tube
Dipole West (16 shots)
Distant Plain 1,1A,2A,3,4 (Blowdown II), 5,6,6A
Dive Under (4 shots)
Dugout
Edwards Air Force Base (3 shots)
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MACEX (2 shots)
Middle Course I (6 shots)
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Mole 100 (12 shots)
Mole 200 (13 shots)
Mole 300 (14 shots)
Mole 400 (6 shots)
Mono Lake 1965 (10 shots)
Mono Lake 1966 (18 shots)
Mono Lake 1969 (5 shots)
MTCE (23 shots)
NOL (Chesapeake Bay-1964-11 shots)
NOL (Chesapeake Bay-1965-9 shots)
NOL (Dahlgren-61 shots)
NOL (Sevier Bridge Reservoir)
NOL (Stump Neck-122 shots)
North Wind
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PLEX

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Sandia-Coyote (10 shots)
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pre-Schooner II
Scooter
Shatts
Snowball
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SSTV (4 shots)
Stagecoach I,II,III
Sterling HE
Suffield 1959 (5 shots)
Suffield 1960
Suffield 1961
Suffield 1963 (5 shots)
Suffield 1965 (4 shots)
Toboggan (98 shots)
Tonopah (53 shots)
Trinidad B (8 shots)
Trinidad C (6 shots)
Trinidad D (4 shots)
Trinity HE
Tugboat I (5 shots)
Tugboat II (3 shots)
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ABBREVIATIONS

AEC - Atomic Energy Commission (now Energy Research and Development Agency (ERDA)).

AFSWC - Air Force Special Weapons Center

ARPA - Advanced Research Projects Agency

BRL - U.S. Army Ballistic Research Laboratory

DNA - Defense Nuclear Agency (formerly DASA)

DoD - Department of Defense

NOL - Naval Ordnance Laboratory

SAMSO - Space and Missile Systems Organization

TTCP - Tri-Partite Technical Cooperation Program

UETP - Underground Explosion Test Program

WES - Army Engineer Waterways Experiment Station

CHRONOLOGICAL LISTING OF CITED HIGH EXPLOSIVE SHOTS
WITH HOB, EXPLOSIVE SOURCE, AND WEIGHT

Date (year)	Event (series)	HOB (ft)	Explosive	Weight (lb)
1945	Trinity HE	Unspecified	TNT	216,000
1950	Dahlgren (NOL)	UW -2.3 to -5.4	TNT	4,200
	Stump Neck (NOL)	UW -17.0	TNT	100;600
1951	Jangle HE	-1.9 to -4.7, surface tangent	TNT; Pentolite	216-40,000; 177
	Stump Neck (NOL)	UW -1.25	Blasting gelatin	100
	UET (Dugway)	-7 to -35	TNT	110-320,000
1952	Dahlgren (NOL)	UW -5	TNT	100;600;3,600;4,200
	Mole (100) (200)	-6.35 to +6.35	TNT	256
	PPG	Surface (excavated)	C2,R-7-HCA	2,000-40,000
	Tumbler HE	Surface or half-buried	TNT	250
	WES, Miss.	River bottom and mid-depth	TNT	256;600;3,600;4,200
	WES, Pond	UW -1.45 to -3.44	HBX-1	106
	WES, Potomac	UW -1.46 to -3.47	HBX-1	109
1953	Mole (300)	-4.7 to +3.17	TNT, dynamite	256, 290
	Sevier Bridge (NOL)	UW -11.1	TNT	90,000
	Tumbler HE	Surface, half buried	TNT	250
1954	Mole (400)	-0.83 to -6.35	TNT	256
1955	WES Big Black River	Surface (concrete slab)	TNT	256
1958	Sandia I	-6.35 to -25.4	TNT	256
1959	Cowboy	-45 to -110	Pelletol	100-2,000
	Sandia II	to -30	TNT	256
	Sandia Tuff	-6.35 to -22.5	TNT	256
	Suffield 1959	Surface	TNT	10,000
	Toboggan	-2.0 to -3.0	TNT	256

Date (year)	Event (series)	HOB (ft)	Explosive	Weight (lb)
1960	Buckboard	-5 to -60	TNT	1,000;40,000
	Hobo	-240 to -1040	TNT	100-973
	Little Ditch	-3.17 to -12.7	TNT	256
	Scooter	-125	TNT	1,000,000
	Stagecoach I,II,III	-17 to -80	TNT	40,000
	Suffield 1960	Surface	TNT	40,000
	Toboggan	-2.0 to -3.0	TNT	256
1961	Banshee I	25,250	Pentolite	500
	Edwards AF Base	Surface to 13.5	Unspecified	500-10,000
	Hydra IIA	UW -2.2 to -140	HBX-1	10,000
	Rowboat	UG -1.0 to -1.5 crater radius	TNT	278
	Suffield 1961	Surface	TNT	200,000
	WES (LOTS)	UW -0.5 to -36.5	TNT, C4	125;385;800
	White Tribe I,II,III	Surface	TNT	34,680
1962	Banshee II	103,460	Pentolite	500
	pre-Buggy I (1-6)	-3.5	Nitromethane	1,000
1963	Air Vent I	-17.2	TNT	40,000
	Blowdown (Dolphin)	136	TNT	100,000
	Distant Plain 4 (Blowdown II)	Surface	TNT	100,000
	pre-Buggy I (A-D)	-3.5	Nitromethane	5,000
	pre-Buggy II	-19.8 to -23.0	Nitromethane	1,000
	Igloo-ADC	Surface	Rocket Propellant	300
	Suffield 1963	Surface	TNT	10,000-40,000
1964	Air Vent II	UG -.86 to -25 ft	TNT	256
	Air Vent III	Surface	TNT	1,000-6,000
	Chase II	UW -5900	Ammunition	4,000,000
	Dugout	-59 (half buried)	Nitromethane	200,000
	Flat Top I,II,III	Half buried	TNT	40,000

Date (year)	Event (series)	HOB (ft)	Explosive	Weight (lb)
1964	NOL Chesapeake Bay	UW -60 to -100	Lithanol, Pentolite	300
	pre-Schooner A,B,C,D	-42 to -66	Nitromethane	40,000
	Sailor Hat Alpha	UW -200	HBX	40,000
	Snowball (Suffield)	Surface tangent	TNT	1,000,000
	Tonopah	0 to -12	TNT	256
1965	pre-CAPSA	-9.7	TNT	256
	Chase III,IV	UW -1000 -900	Ammunition	600,000-1,400,000
	Hastings	Surface	Cyclotol	96-515
	Mono Lake	UW 0.0 to -51.5	TNT	10,000; 900
	MTCE	Half buried, tangent above, tangent below	TNT	2,000;16,000;4,000
	NOL (PW)	UW -60 to -100	H_2O_2/Al; Pentolite	300
	North Wind	UW -200	Unknown	1,350
	pre-Schooner II	-71	Nitromethane	200,000
	Sailor Hat B,C,D	Surface (shore)	TNT	1,000,000
	Sotran 1,2	Surface	TNT	20,000-100,000
	Suffield 1965	25	TNT, Oxygen and Methane	1,000-2,000
	Tonopah	-6 to -10	TNT	320-1,280
1966	Chase V,VII	UW -3750, -2900	Ammunition	800,000-2,000,000
	Distant Plain 1	85.9	TNT	40,000
	Distant Plain 2A	Surface (in balloon)	Oxygen and Propane	40,000
	Distant Plain 3	Half buried	TNT	40,000
	pre-Gondola 1 Cal.	-12.2 to -23.3	Nitromethane	1,000
	pre-Gondola I A-D	-42.5 to -56.9	Nitromethane	40,000
	Mono Lake	UW -0.42 to -600	Anoil, slurry, Nitromethane, TNT	600-9,233
	Sandia Coyote	-9.52	TNT	256
	Sotran 3,4	Surface	TNT	40,000
	Sterling HE	-2727	Nitromethane	5,400
	Tonopah	-6.0 to -6.9	TNT	128-1,600 (row)

Date (year)	Event (series)	HOB (ft)	Explosive	Weight (lb)
1967	Distant Plain 1A	25	TNT	40,000
	Distant Plain 5	Surface tangent	TNT	40,000
	Distant Plain 6	Surface tangent	TNT	200,000
	Distant Plain 6A	Surface tangent	TNT	40,000
	pre-Gondola II	-48.8 to -59.9	Nitromethane	275,000 (row)
	Sotran 5	Surface	TNT	100,000
1968	AN/FO	Surface	ANFO	260-4,000
	CAPSA	-10 to -47.9	TNT, Nitromethane	1,000-30,478
	pre-Gondola III, 1 and 2	Surface	Nitromethane	42,000; 420,000
	IITRI	UW -1825 to -3100	Slurry	24,000-62,000
	Mine Ore	-.10 charge radius	TNT	200,000
	Mine Shaft Calibration	Surface tangent, below, above	TNT	1,000
	Mine Under	15	TNT	200,000
	Prairie Flat	Surface tangent	TNT	1,000,000
1969	AN/FO I,II,III	Surface	ANFO	40,000-200,000
	Chase XVI-XXII	UW -750 to -7500	Conventional Ammunition	956,000-4,300,000
	Diode Tube	-2700	Methane and Oxygen	200,000
	HOB	5.2 to 72.0	TNT	1,000
	Igloo A,B,C	Surface	C4	100-500
	Mineral Lode	-100	Slurry	32,000
	Mineral Rock	Half buried	TNT	200,000
	Mono Lake	UW -5.2 to -10.7	HBX-1	10,000 to 11,500
	Tugboat 1A-1E	UW -17.3 to -42.9	AANS	2,000-20,000
1970	Blast Directing Experiment (Dial Pack)	Above ground to ∿30	TNT	4,000
	China Lake	Surface	Tritonal	5,500
	Dial Pack	Surface tangent	TNT	1,000,000
	Dive Under	UW -200	HBX-1	10,000-40,000
	Humid Water	-2700	Methane and Oxygen	630,000
	Middle Course I	-20.9 to +3.8	AANS	2,000
	SSTV	UW -75	HBX-1	10,000
	Tugboat II	UW -42	AANS	80,000
	Trinidad D series	-11.5 to 25.2	ANFO, AANS	200-4,000

Date (year)	Event (series)	HOB (ft)	Explosive	Weight (lb)
1971	ANFO IV,V	Surface tangent, half buried	ANFO	50,000
	Diamond Mine HE	UG -Diamond Mine Cavity	Nitromethane	985
	Diamond Ore IIA	UG -19.7 to -41.1	AN Slurry	32,000
	Eskimo I	Surface	Unspecified	200,000
	Igloo I,II	Surface	C4	125-250
	MACEX	Surface tangent	TNT	1,000
	Middle Course II	-4 to -35	AANS	2,000
	Middle Gust Calibration	Surface tangent, half buried	TNT	1,000
	Middle Gust I,II	Half buried, 16	TNT	40,000-200,000
	Mine Throw I	Surface tangent	ANFO	236,000
	pre-Mine Throw I,II,III	Tangent below(cavity)	ANFO	12,000;9,000
	Trinidad B	-15.2 to -28.1	ANFO, AANS	2,000
	Trinidad C	-17.3 to -23.6	AANS	2,000
1972	Diamond Ore IIB	-5 to -25	TNT, AANS	2,000-36,000
	Middle Gust III,IV,V	Surface tangent; half buried	TNT	40,000-200,000
	Mixed Company Calibration	Surface tangent; half buried	TNT	1,000
	Mixed Company I,II,III	Half buried; surface tangent	TNT	40,000-1,000,000
	Mine Dust HE	-14 below tunnel	Nitromethane	1,000
	PACE	Half buried to 2 radii above	TNT	1,000
1973	AFWL 1-5	Tangent above, tangent below, partially buried	TNT	1,000
	Diamond Ore IIC	-40	TNT,AANS	20,000
	Dipole West 1-2	45 to 134	Pentolite, TNT	1,000-2,000

Date (year)	Event (series)	HOB (ft)	Explosive	Weight (lb)
1973	Eskimo II	Surface	Tritonal	24,000
	Essex 1; Phase I	-19.2 to -39.4	Nitromethane	20,000
	Middle Gust CIST	-30 to -40	PETN	150
	pre-Mine Dust, II	UG cavity	TNT	1,000
	pre-Mine Throw IV	Surface tangent, half buried	TNT, Nitromethane	256-203,500
	PLEX	-0.41	TNT	1,000
	Pokeholes	-10.1 to -13.7	Slurries, ANFO, TNT	500
1974	AN/FO (5 shots)	4.5	ANFO	1,000
	Dipole West 12-16	Surface	Pentolite	200-400
	Eskimo III	Surface	Tritonal	350,000
	Essex 1, Phase 2	-9.8 to -39.4	Nitromethane	20,000
1975	pre-Dice Throw II, 1-2	Surface tangent	TNT, ANFO	200,000; 240,000
	Dipole West 16	Surface	Pentolite	400
	Essex; Phase 3	-19.2 (half buried)	Nitromethane	20,000
	Eskimo IV	Surface	TNT	37,000
	Hard Pan I-1	-4.5	PETN	--
	Hard Pan I-2A	-8.35 and -6.63	ANFO	62,000
1976	Dice Throw	Surface tangent	ANFO	1,000,000

CODE:
HOB: height of burst above original ground surface (depth of burst is shown as negative HOB).
Surface burst: charge at ground level.
Surface tangent (tangent above): charge resting on ground surface, touching ground at only one point.
Tangent below: top of charge flush with ground surface.
UW: Underwater.

LIST OF CITED HIGH EXPLOSIVE SHOTS BY CHARGE WEIGHT (in diminishing sequence)

Approx. Weight (lb)	Shots
4,000,000	Chase II,XXII
2,000,000	Chase II, V, XVI
1,000,000	Chase III Dial Pack Dice Throw Mixed Company Prairie Flat Sailor Hat B,C,D Scooter Snowball
800,000	Chase VII
600,000	Chase IV Humid Water
420,000	pre-Gondola III, Phase 2 Mine Throw II (as planned)
350,000	Eskimo III
320,000	UET Dugway
275,000	pre-Gondola II
236,000	Mine Throw I
200,000	ANFO III pre-Dice Throw II Diode Tube Distant Plain 6 Dugout Eskimo I Middle Gust II,III,IV Mine Ore pre-Mine Throw IV, Event 6 Mine Under Mineral Rock pre-Schooner II Suffield 1961 Trinity HE

Approx. Weight (lb)	Shots
100,000	Blowdown Distant Plain 4 (Blowdown II) Sotran
90,000	NOL Sevier Bridge
80,000	Tugboat
62,000	Hard Pan I-2A IITRI 3 - 1968
50,000	ANFO IV,V
40,000	Air Vent Phase I ANFO I,II Buckboard Distant Plain I, IA, 2A, 3, 5, 6A Dive Under Flat Top I, II, III pre-Gondola I, A, B, C, D pre-Gondola III, Phase I Jangle HE-2 Middle Gust I, V Mixed Company I, II Pacific Proving Ground HE Sailor Hat A pre-Schooner A, B, C, D Sotran Stagecoach I, II, III Suffield 1960, 1963 UET
37,000	Eskimo IV
36,000	Diamond Ore IIB
35,000	White Tribe
32,000	Diamond Ore IIA Mineral Lode
30,000	Capsa Hard Pan I2b Pacific Proving Ground HE
24,000	Eskimo II IITRI 1,2
20,000	Diamond Ore IIC Essex I, Phase 1, 2, 3 Pacific Proving Ground HE Sotran Tugboat

Approx. Weight (lb)	Shots
16,000	MTCE
14,000	pre-Mine Throw IV, Event 3
12,000	pre-Mine Throw I, II
10,000	Dive Under Edwards Air Force Base 1, 2 Hydra IIA pre-Mine Throw I, II, III Mono Lake 1969 Pacific Proving Ground HE SSTV Suffield 1959, 1963 UET
9,000	pre-Mine Throw III Mono Lake 1965, 1966
6,000	Air Vent Phase III
5,000	pre-Buggy I China Lake Sterling HE
4,000	AN/FO 1968 Blast Directing (Dial Pack) Diamond Ore IIB MTCE NOL Dahlgren Trinidad D
3,600	NOL Dahlgren
3,000	MTCE
2,500	Jangle HE 1, 3, 4, 5-7 UET
2,000	Cowboy Diamond Ore Dipole West 2-5, 7-11 Middle Course I, II Mono Lake 1966 Pacific Proving Ground HE Suffield 1965 Trinidad B, C, D Tugboat WES Mississippi
1,600	Tonopah
1,500	Hard Pan I-1
1,350	North Wind

Approx. Weight (lb)	Shots
1,000	AFWL 1-5
	Air Vent Phase III (3 shots)
	AN/FO 1974 (5 shots)
	Buckboard (10 shots)
	pre-Buggy I, II
	Capsa
	Cowboy
	Diamond Mine HE
	Diamond Ore IIB
	Dipole West 1, 6
	pre-Gondola I Calibration
	HOB 1-12
	Hobo 2a, 3
	MACEX
	Middle Gust Calibration
	Mine Dust HE
	pre-Mine Dust, Phase II
	Mine Shaft Calibration
	pre-Mine Throw IV, Cal 1 & 2, Events 1-4
	Mixed Company Calibration
	PACE
	PLEX
	Shatts
	Suffield 1965
	Tonopah
	UET
900	Mono Lake 1965 Calibration
600	Mono Lake 1966
	NOL Dahlgren
	NOL Stump Neck
	WES Mississippi
500	Banshee I, II
	Cowboy
	Edwards Air Force Base 3
	Hard Pan I-2A
	Hastings
	Hobo 4
	Igloo C
	Pokeholes
400	Dipole West 12, 13, 15, 16
	WES - Lots
300	Igloo-ADC
	Igloo-B
	Mole 300

Approx. Weight (lb)	Shots
300	NOL Chesapeake Bay Tonopah UET WES - LOTS
278	Rowboat
256	Air Vent Phase II AN/FO 1968 pre-Capsa Igloo Phase II Little Ditch pre-Mine Throw IV, Event 7 Mole, 100, 200, 300, 400 Sandia I, II, Tuff, Coyote Toboggan Tonopah Tumbler HE WES - Big Black River WES - Mississippi
200	Cowboy Dipole West 14 Jangle HE 8-10 Little Ditch
100	Cowboy Hastings Hobo 1 Igloo A Igloo Phase 1 NOL Dahlgren NOL Stump Neck Tonopah UET WES - LOTS, Pond, Potomac

TNT-EQUIVALENT EXPLOSIVE WEIGHT APPROXIMATIONS*
(averaged values in regions where $35 < \Delta p < 700$ kPa [2])

Explosive	Equivalent Weight Pressure	Equivalent Weight Impulse	Relative Energy**	Reference
TNT	1.00	1.00	1.00	[1,2]
Ammonium Nitrate	0.84	--	0.60	[1]
ANFO (95/5)	0.85	--	--	[2]
Composition C-4	1.37	1.19	1.63	[2]
Cyclatol	1.14	1.09	--	[2]
HBX-1	1.17	1.16	1.36	[2]
HBX-3	1.14	0.97	1.11	[2]
Nitromethane	1.00	--	1.01	[1]
Pentolite	1.42	1.00	1.42	[2]
PETN	1.27	--	1.80	[1,2]
Tritonal	1.07	0.96	1.03	[2]
Black Powder	0.46	--	0.10	[1]

*Example: At a given distance from 1 kg of Pentolite, the same overpressure would result from using 1.42 kg TNT.

**Obtained from equivalent weights EW(Δp) x EW(I) from data [2].

1. Kinney, Gilbert F., *Explosive Shocks in Air*, New York: The MacMillan Company, 1962, pp 165-170.

2. Swisdak, M.M., Jr. (Editor), *Explosion Effects and Properties*, Report NSWC/WOL/TR-75-116, Naval Surface Weapons Center, Silver Spring, MD, Oct 1975.

SHOT SUMMARIES
(arranged alphabetically by name)

SERIES: AFWL

LOCATION: Fort Polk, Louisiana

DATE:
AFWL-1 24 September 1973 at 1244 (CDT)
AFWL-2 25 September 1973 at 0941
AFWL-3 27 September 1973 at 1250
AFWL-4 26 September 1973 at 1340
AFWL-5 29 September 1973 at 1238

CHARGE: TNT. Spherical cast charges detonated near-surface by a 10-inch diameter sphere of 50/50 pentolite cast into the center of the charge and initiated by a #8 military blasting cap. Detonated tangent below, tangent above, half buried, three-quarter buried, or three-quarter above ground surface.

WEIGHT (lb): 1,000 each

GEOLOGY: Siltstone, sandy silt, or silty sand

METEOROLOGY:	AFWL-1	AFWL-2	AFWL-3	AFWL-4	AFWL-5
Temperature (°F)	83	80	85	87	79
Wind Direction (°)	181	140	117	130	147
Wind Speed (mph)	8	8	4	6	1

TEST OBJECTIVE: Investigate the effect of a siltstone test medium on crater formation and dimensions, ejecta formation and distribution, ground motion, airblast, and permanent ground displacement.

REFERENCES:

Harvey, William T., et al, *Near-Surface Cratering Experiments*, Fort Polk, Louisiana, November 1975, Air Force Weapons Laboratory, AFWL-TR-74-351.

AIR VENT - Phase I - 1 shot
Phase II - 20 shots
Phase III - 5 shots

SERIES: Ferris Wheel

LOCATION: Nevada Test Site, Frenchman's Flat, Area 5

DATE: December 1963 through February 1964

CHARGE: TNT. Phase I: 40,000-lb sphere at DOB 17.19 ft. Phase II: 20 256-lb spheres at DOB .86 ft to 25.4 ft. Phase III: 3 1000-lb, and 2 6000-lb spheres at ground surface center of gravity.

WEIGHT: (lb)	I	II	III
	40,000	256 (20)	1,000 (3) and 6,000 (2)

Note: Event III IA-D were 64-lb shots.

GEOLOGY: Playa alluvium: A compact fine silt and clay which is uniform laterally and vertically. Average near-surface wet density of media: 95.9 lb/cu ft. Average near-surface moisture content: 14.2 percent. Flat surface.

METEOROLOGY: Phase I: Surface winds dead calm from ground surface to 1000 above grade; clear day.

TEST OBJECTIVE: Correlate previous high explosive and nuclear cratering detonations with proposed Ferris Wheel test series. Measure true and apparent craters and acquire and analyze ejecta data. Compare effects in Area 5 playa with prior effects in Area 10 alluvium from the Scooter and Jangle HE-2 explosions.

REFERENCES: Merritt, M. L., *Ferris Wheel Series, Air Vent/Flat Top Events Project Officers Report, Scientific Directors Summary*, 27 September 1968, POR-3000.
Flanagan, T. J., *Project Air Vent Crater Studies*, April 1966, Sandia Laboratory, SC-RR-64-1704.
Ahlers, Edward B., *Crater Ejecta Studies - Air Vent Phase I, Final Report*, May 1965, IIT Research Institute, IIIRI M-6072FR.
Carlson, R.H. and Jones, G. D., *Project Air Vent Ejecta Distribution Studies*, November 1964, The Boeing Company, D2-90575.

AN/FO (1968)
23 shots

SERIES: AN/FO

LOCATION: Rattlesnake Flat near Hawthorne, Nevada

DATE: Spring 1968

CHARGE: Ammonium nitrate mixed with 5 percent fuel oil (AN/FO). Three configurations were used: (1) hemispherical charge of field mixed AN/FO obtained by retaining the charge base within a low cardboard cylindrical fence; (2) hemispherical arrangement with pre-mixed AN/FO; (3) 50-lb bags of AN/FO stacked in a near hemispherical shape. Fired on the surface.

WEIGHT (lb): 260 to 4,000

GEOLOGY:

METEOROLOGY:

TEST OBJECTIVE: Establish blast performance of AN/FO and determine if pre-mixed and field-mixed AN/FO explode in similar fashion.

REFERENCES:

Sadwin, L. D. and Pittman, J. F., *Airblast Characteristics of AN/FO, Phase 1*, 30 April 1969, Naval Ordnance Laboratory, NOLTR 69-82.
Petes, J., *Ammonium Nitrate/Fuel Oil as an Explosive*, April 1969, presented to Panel N-2 TTCP.

AN/FO (1974)
5 shots

SERIES: AN/FO

LOCATION: Atlantic Fleet Weapons Range, Vieques Island Area

DATE: June 1974

CHARGE: AN/FO poured into 3-ft diameter circular cylinder mounted on 4-1/2 ft-high platform. Booster was 5 lbs of C-4 placed on the platform at the base of the cylinder.

WEIGHT (lb): 1,000 each

TEST SITE: Located near a body of water, with easy access between shore and water. The water surface is usually free of significant swell and wind waves.

METEOROLOGY:

TEST OBJECTIVE:

REFERENCES:

Ward, J.M., *Hovercraft Rigid Body Response to Free Field Airblast*, Naval Surface Weapons Center, 28 October 1975, NSWC/WOL/TR 75-42.

SERIES: ANFO

LOCATION: Defence Research Establishment, Watching Hill, Suffield, Ralston, Alberta, Canada

DATE: Event 1: 14 August 1969 at 1100 MST
Event 2: 21 August 1969 at 1100 MST
Event 3: 28 August 1969 at 1100 MST

CHARGE: AN/FO. Event 1: Hemispherical charge of bagged AN/FO.
Events 2 and 3: Hemispherical charges, bulk in fiberglass shell.
All were surface detonations.

WEIGHT (lb)	I	II	III
	40,000	37,600	200,000

GEOLOGY: Silty clay underlain by a 27-ft bed of fine silty sand.

METEOROLOGY:

TEST OBJECTIVE: Evaluate the performance of an explosive mixture of ammonium nitrate and fuel oil. Verify the detonability. A model silo and frame house were exposed in Event III.

REFERENCES:

Sadwin, L. D. and Swisdak, M.M., Jr., *AN/FO Charge Preparation for Large Scale Tests*, 8 October 1970, Naval Ordnance Laboratory, NOLTR 70-205.
Sadwin, L.D. and Swisdak, M.M.,Jr., *Blast Characteristics of 20 and 100 Ton Hemispherical AN/FO Charges, NOL Data Report*, 17 March 1970, Naval Ordnance Laboratory, NOLTR 70-32.

ANFO IV

SERIES: ANFO

LOCATION: Defence Research Establishment, Watching Hill, Suffield, Ralston, Alberta, Canada

DATE: 21 October 1971 at 1200

CHARGE: Ammonium nitrate mixed with 5 percent fuel oil (ANFO), placed in 45-lb paper bags. Spherical, tangent to and above the ground surface, supported by styrofoam. The base consisted of two layers of 3/4-inch plywood. There were two fireball anomalies, possibly due to defects in the charge construction.

WEIGHT (lb): 50,000

GEOLOGY: Clay and silt with occasional sand lenses to a depth of 200 ft.

METEOROLOGY: At 1/2 meter, wind direction 235°; wind speed 4.8 mph. Air temperature 54.6°; relative humidity 48 percent; pressure at GZ 13.68 psi; bright sunshine.

TEST OBJECTIVE: Obtain airblast information and cratering data for charges composed of ANFO, for comparison with data from similar charges composed of TNT, e.g., Distant Plain 6, Prairie Flat, and Dial Pack. Shock wave distance-time measurements were made.

REFERENCES:

Anderson, J.H.B., *Observations on the Blast Phenomenology of Unconfined Charges of Ammonium Nitrate/Fuel Oil Explosive (ANFO IV and ANFO V - October 1971)*, June 1972, Defence Research Establishment Suffield. AD905246.

SERIES: ANFO

LOCATION: Defence Research Establishment, Drowning Ford Range, Suffield, Ralston, Alberta, Canada

DATE: 19 October 1971 at 1200

CHARGE: Ammonium nitrate mixed with 5 percent fuel oil (ANFO) in 45-lb paper bags. Spherical, half-buried in the ground in a hemispherical hole.

WEIGHT (lb): 47,000

GEOLOGY:

METEOROLOGY: At 2 meters, wind directions 180°; wind speed, 15.6 mph. Air temperature 54.2°F; relative humidity 48 percent; pressure at GZ 13.5 psi. Sky condition: sunshine moderate through zero with 4/10 cirrus.

TEST OBJECTIVE: Obtain airblast information and cratering data for charges composed of ANFO, for comparison with data from similar charges composed of TNT, especially Distant Plain 3.

REFERENCES:

Anderson, J.H.B. *Observations on the Blast Phenomenology of Unconfined Charges of Ammonium Nitrate/Fuel Oil Explosive (ANFO IV and ANFO V-October 1971)*, June 1972, Defence Research Establishment Suffield, TN 319, AD905246.

BANSHEE, Phase I, II

SERIES: Banshee (Balloon and Nike Scaled High-Explosive Experiment)

LOCATION: White Sands Missile Range, New Mexico

DATE: July and August 1961: May through September 1962 at 0600 to 1655 MST

CHARGE: 50/50 pentolite (50 percent PETN and 50 percent TNT). Molded spheres cast by the pellet or briquette tamping process. Diameter 25.52 in. ±0.44 in. Each sphere was nested in a nylon webbing sling and carried to detonation height in a large helium-filled polyethylene balloon. Burst altitude ranged from 25,250 ft to 103,460 ft (MSL).

WEIGHT (lb): 500 each

GEOLOGY:

METEOROLOGY:

TEST OBJECTIVE: Investigate blast effects produced by the detonation of a conventional explosive at 25,000 ft to 104,000 ft MSL altitude. Phase I was a calibration phase to investigate stationary charge and stationary gage positions. Phase II was to measure airblast effects of an HE warhead on an in-flight Nike-Hercules missile at high altitudes (20,000 ft). Additionally, an M48C1 tank was exposed to evaluate protection afforded launch personnel in case of accidental explosion during launch procedures.

REFERENCES:

Schmidt, John G., *Project Banshee, Phases I and II, Final Report*, October 1965, Ballistic Research Laboratories, BRL-MR 1707.
Kelso, Jack R., *Preliminary Report, Project Banshee Field Operations (1961 and 1962)*, Defense Atomic Support Agency, DASA-543.
Schmidt, John G., *Test of M48C1 Tank Exposed to Blast Produced by 500-pound Sphere of 50/50 Pentolite (Project Banshee)*, January 1963, BRL MR 1453.

BLAST DIRECTING EXPERIMENT (DIAL PACK)

SERIES: Middle North

LOCATION: Defence Research Establishment, Suffield, Alberta, Canada

DATE: 6 August 1970

CHARGE: TNT distributed in a planar array over a half circle of 37.5-ft radius. Charges were composed of a number of 32.6 lb cast blocks each measuring 12 x 12 x 4 inches suspended from a charge support system of telephone poles, wood beams, and steel cables. Detonated with primacord.

WEIGHT (lb): 4,000

GEOLOGY:

METEOROLOGY:

TEST OBJECTIVE: Improve the technique of using explosives distributed in a planar array to generate an air blast overpressure to simulate the blast wave of a TNT hemisphere detonation of a larger yield. Also to verify the accuracy of code predictions and predictions based on scaling considerations.

REFERENCES:

Fugelso, L.E., et al. "Dial Pack Blast Directing Experiment" in *The Shock and Vibration Bulletin, No. 42, Part 4*, January 1972.
Event Dial Pack Symposium Report, Volume 1, The Defence Research Board of Canada, March 1971.

Note: Previous similar experiment with 100-lb TNT was held at General American Research Division's Ballistic Test Station.

BLOWDOWN

SERIES: Dolphin

LOCATION: Iron Range Test Site, Queensland, Australia.

DATE: 18 July 1963 at 0830 Australian time

CHARGE: Spherical charge (12 ft 10 in. diameter) of TNT detonated on a steel tower at a height of 136 ft. The charge was built of tins containing 41 lbs of TNT each. Lightweight plastic-filled tins were used to support the lower surface of the sphere.

WEIGHT (lb): 100,000

GEOLOGY: Low mountainous country with vegetation comprising a light to medium rain forest.

METEOROLOGY: Wind velocity at 250 ft., zero; forest location temperature 12.2° to 13.3°C at 4 ft off ground; humidity 90 percent; pressure: 14.70 psi at 60 ft MSL.

TEST OBJECTIVE: Obtain empirical data on large-scale blast effects damage, tree behavior and associated missile and debris hazards in a rainforest, and to verify tree blowdown prediction techniques.

REFERENCES:

Kelso, Jack R. and Clifford, C.C., Jr., ed., *Preliminary Report Operation Blowdown*, June 1964, Defense Atomic Support Agency, DASA 545.
Campbell, Robert J. and Kelso, Jack R., *Project Dolphin, United States Participation with Australia in a High Explosive Experimental Program at Iron Range, Queensland, Australia*, July 1963, DASA 619.
Roderick, E.J., *Effects of a High Explosive Detonation in a Tropical Rain Forest (Project Dolphin)*, February 1964.

BUCKBOARD
13 shots

SERIES: Plowshare

LOCATION: Nevada Test Site, Area 10

DATE: June through September 1960

CHARGE: TNT. Nine of the 10 1000-lb charges were spherical, one was cylindrical. Two charges each were placed at DOB of 5, 10, 20, and 25 ft. (The cylindrical charge was one of the two placed at DOB of 25 ft.) The three 40,000-pound charges were placed so that their centers were 26, 43, and 60 ft deep, respectively. All charges were covered with approximately 1 foot of sand and stemmed with concrete.

WEIGHT (lb): 1,000 (10 shots)
40,000 (3 shots)

GEOLOGY: Basalt rock, a Quaternary volcanic flow.

METEOROLOGY: For the 40,000 lb shots, see reference SC-4675, p. 247-250.

TEST OBJECTIVE: Cratering tests comparing effects of yield, depth of burst, and surrounding medium. Included study of seismic signals.

REFERENCES:

Vortman, L.J., et al, *Project Buckboard Interim Report*, November 1960, Sandia Corporation, SC-4486 (RR).
Vortman, L.J., *Explosive Cratering Experiments*, May 1961, Sandia Corporation, SCR-406.
Vortman, L.J., *Project Buckboard, 20-ton and 1/2-ton High Explosive Cratering Experiments in Basalt Rock, Final Report*, Sandia Corporation, August 1962, SC-4675 (RR).

pre-BUGGY I
Shots 1-6

SERIES: Plowshare

LOCATION: Nevada Test Site, Area 5

DATE:

	1	2	3	4	5	6	
1962	12/5	12/10	12/11	12/13	12/18	12/19	Single Charge
at	1602	1525	1338	1351	1250	1342	

CHARGE: Liquid explosive nitromethane, which is considered as 1.1 times as powerful as TNT. Contained in a spun aluminum sphere 36 in. in diameter, center detonated. The spheres were placed at the bottom of 42-in.-diameter holes, filled with NM, and stemmed with sand. A capsule containing a radioactive tracer was placed in the center of each charge.

WEIGHT (lb): 1,000 each

GEOLOGY: Gravelly sand, with some boulders and a small amount of silt. (Desert alluvium)

METEOROLOGY:

	1	2	3	4	5	6
Surface Temp., (°C):	18.0	22.0	20.5	15.2	10.2	15.2
Surface Wind Direction(°):	010	160	175	102	102	040
Surface Wind Speed(kts):	08	02	04	03	05	07

TEST OBJECTIVE: Aid in the design of a proposed nuclear row-charge event (Project Buggy). To obtain data on crater dimensions and the venting of explosion products and to assess the effect of varying spacing of charges and DOB.

REFERENCES:

Wray, W.R. and R.B. Pierce, *Project Pre-Buggy, Venting Measurements*, August 1964, Lawrence Radiation Laboratory, PNE-301F.
Rooke, A.D. and L.K. Davis, *Project Pre-Buggy, Emplacement and Firing of High-Explosive Charges and Crater Measurements*, February 1965, Army Corps of Engineers, PNE-302.

SERIES: Plowshare

LOCATION: Nevada Test Site, Area 5

DATE:	A	B	C	D	
1963	1/16	1/23	1/31	2/7	Multiple Charge
at	1432	1422	1317	1459	

CHARGE: Liquid explosive nitromethane, which is considered as 1.1 times as powerful as TNT. Contained in a spun aluminum sphere 36 in. in diameter, center detonated. The spheres were placed at the bottom of 42-in-diameter holes, filled with NM, and stemmed with sand. A capsule containing a radioactive tracer was placed in the center of each charge.

WEIGHT (lb): 5,000 each multiple charge

GEOLOGY: Gravelly sand, with some boulders and a small amount of silt. (Desert alluvium)

METEOROLOGY:	A	B	C	D
Surface Temp. (°C):	12.0	22.3	15.2	24.8
Surface Wind Direction (°):	140	150	235	140
Surface Wind Speed (kts):	03	04	13	04

TEST OBJECTIVE: Aid in the design of a proposed nuclear row-charge event (Project Buggy). To obtain data on crater dimensions and the venting of explosion products and to assess the effect of varying spacing of charges and DOB.

REFERENCES:

Wray, W.R. and R.B. Pierce, *Project Pre-Buggy, Venting Measurements*, August, 1964, Lawrence Radiation Laboratory, PNE-301F.

Rooke, A.D. and L.K. Davis, *Project Pre-Buggy, Emplacement and Firing of High-Explosive Charges and Crater Measurements*, February 1965, Army Corps of Engineers, PNE-302.

pre-BUGGY II

SERIES: Plowshare

LOCATION: Nevada Test Site, Area 5, south of the Pre-Buggy I site.

DATE: June and August 1963: Row C 5/28 at 1243 PDT; Row G 6/5 at 1500; Row D 6/7 at 1315; Row B 6/11 at 1200; Row C Prime 6/13 at 1440; Row H 8/2 at 1425; Array F 8/6 at 1530.

CHARGE: Liquid explosive nitromethane placed in five rows of 5 charges each, one row of 13 charges, and four single charges. Each charge was 1,000 lb of NM contained in a 36-in-diameter spun aluminum sphere. Thirty charges were at 19.8 DOB; 10 at 23.0 DOB; two at 18.6 DOB. Spacing ranged from 20.6 ft to 30.9 ft.

WEIGHT (lb): 1,000 each (42 charges)

GEOLOGY: Desert alluvial fan; gravelly sand, well graded, with some silt and occasional cobbles and boulders.

METEOROLOGY:

TEST OBJECTIVE: Extend and refine the Pre-Buggy I series. Study dimensions and geometry of the apparent craters resulting from the detonation of row charges. Minimal programs devoted to ground motion, cloud and base surge growth and ejecta.

REFERENCES:

Spruill, J.L. and F.F. Videon, *Project Pre-Buggy II Final Report, Studies of the Pre-Buggy II Apparent Craters*, June 1965, Army Engineer Nuclear Cratering Group, PNE 315 F.

CAPSA - 13 Shots
pre-CAPSA - 2 Shots

SERIES: CAPSA

LOCATION: Albuquerque, New Mexico

DATE: Pre-Capsa - 3 and 6 May 1965
Capsa - 16 August - 25 July, 1968

CHARGE: Events 1 - 9 and pre-Capsa: TNT
Events 10, 12, 13: Nitromethane
Event 11: Composition B

	1	2	3	4	5	6	7	8	9	10	11	12	13	pre-Capsa
DOB (ft)	15	12.5	10	17.5	15	17.5	10	12.5	12.5	12.5	47.9	12.5	15	9.7

WEIGHT (lb): Events 1-10: 1,000; Event 11: 30,478; Event 12: 977; Event 13: 981
pre-Capsa: 256 each

GEOLOGY: Albuquerque fan delta alluvium.

METEOROLOGY:

TEST OBJECTIVE: Measure airblast along the ground and along an airborne string of gages suspended beneath balloons at 80 ft and 250 ft horizontally from surface ground zero.

REFERENCES:
Vortman, L. J., Sandia Laboratories, Albuquerque, New Mexico - unpublished data.

CHASE II, III, IV

SERIES: Chase

LOCATION: Chase II: Atlantic Ocean, 38° 49'N 72°14'30" W
Chase III: Atlantic Ocean, 37°11'48"N, 74°21'06"W
Chase IV: Atlantic Ocean, 37°11'34"N, 74°26'34"W

DATE: Chase II: 17 September 1964 at 2207 Z
Chase III: 15 July 1965 at 1416 Z
Chase IV: 16 September 1965 at 1951 Z

CHARGE: Conventional ammunition and explosives. Loaded in ship hold and detonated at depth of: Chase II: 5,900 ft in 7,000 ft depth of water
Chase III:1,000 ft in 5,000 ft depth of water
Chase IV: 900 ft in 5,100 ft depth of water

WEIGHT: (lb)	II	III	IV
	4,000,000	1,400,000	600,000

GEOLOGY:

METEOROLOGY:

TEST OBJECTIVE: Efficient disposal of unserviceable conventional ammunition and explosives, which procedure resulted in off-site and on-site seismic measurement, infrared scanning measurements to determine water circulation, hydroacoustic measurements, and containment probabilities assessments.

REFERENCES:

Weinstein, Marvin S. and Young, David F., *Surveillance of Underwater Explosions, State-of-the-Art Report, Technical Progress Report, No. 22*, September 1968, Underwater Systems, Inc.

K. W. Kaulum and M.A. Olson, *Containment of Explosion Products from a Deep Underwater Explosion (Chase V) - Final Report*, 5 May 1967, Naval Radiological Defense Laboratory, USNRDL-TR-67-60.

CHASE V

SERIES: Chase

LOCATION: Atlantic Ocean, 39°28'N, 125°48'W

DATE: 24 May 1966 at 0549 Z

CHARGE: Unserviceable conventional ammunition detonated 3750 ft below the surface in water 12,500 deep. The explosives were loaded in a EC2-S-C1 class freighter and pressure detonators placed in the #2 hold. The ship was scuttled at the shot site. A red flourescent dye was placed in the ship to tag the explosion products.

WEIGHT (lb): 2,000,000

GEOLOGY:

METEOROLOGY:

TEST OBJECTIVE: Study explosion products in subsurface waters with regard to containment below the surface layer and, if complete containment was not achieved, the fraction of explosion products injected into the surface layer. Secondarily, measure vertical distribution below the surface layer immediately after the hydrodynamic migration phase of the explosion bubble and after a few days.

REFERENCES:

Containment of Explosion Products from a Deep Underwater Explosion (Chase V) Final Report, 5 May 1967, Naval Radiological Defense Laboratory, USNRDL-TR-67-60.

Weinstein, Marvin S. and Young, David F., *State-of-the-Art Report, Surveillance of Underwater Explosions Technical Progress Report No. 22*, 3 September 1968, Underwater Systems, Inc.

CHASE VII, XVI-XXII

SERIES: Chase

LOCATION: Atlantic Ocean, approximately 100 mi east of Kittyhawk, N. C.

DATE: Chase VII: 29 July 1966
Chase XVI-XXII: 13 August 1969 - 20 August 1970

CHARGE: Conventional ammunition and explosives loaded in ship hold and detonated at depth of 750 ft to 7500 ft in 7500 ft water depth.

WEIGHT: (lb)	VII	XVI - XXII
	800,000	956,000 - 4,300,000

GEOLOGY:

METEOROLOGY:

TEST OBJECTIVE: Hydroacoustic seismic signal analysis.

REFERENCES:

Young, David F., *Spectral Analysis of Seismic Signals Generated by Chase VII and Chase V Detonations*, 28 November 1967, Underwater Systems, Inc.
Weinstein, M. S., *Initial Study of Hydroacoustic Reverberations from Large Underwater Detonations*, 8 October 1974, Underwater Systems, Inc., AD C000880.

SERIES: China Lake

LOCATION: Naval Weapons Center, China Lake, California

DATE: 6 August 1970

CHARGE: Fifteen 750-lb M-117 bombs with Tritonal explosive, an aluminized TNT. Stacked three high and five wide and individually fuzed. Surface detonation.

WEIGHT (lb): 5,500

GEOLOGY:

METEOROLOGY:

TEST OBJECTIVE: To extend knowledge of blast interaction with a bus, Navy pickup camper, and 1/4-inch plate glass window and to compare results with similar tests with models exposed in Dial Pack events.

REFERENCES:

Custard, George H. and Thayer, John R., *Target Response to Explosive Blast*, September 1970., Falcon Research and Development, AD715 475.

COWBOY
Shots 3-17

SERIES: Plowshare

LOCATION: Carey Salt Mine, Winnfield, Louisiana.

DATE: Phase I: 18 December 1959 (shots 3 and 4)
Phase II: 22 January to 4 March 1960

CHARGE: Pelletol 1, a waterproof free-running blasting agent of slightly oval-shaped smooth pellets about 3/32-in. in diameter. Pelletol energy is considered to be 900 kilocalories per kilogram and the detonation velocity is approximately 5000 meters per second. Both seismically coupled and seismically decoupled shots were fired. Coupled shots were fired at the bottom of shafts dug 45 to 110 ft below the mine floor. Shots 3 and 4: two boxes of HE were placed face to face on a platform resting on a tripod in a 12-foot spherical room. Shots 5, 6, 8, 10, 12 and 14: assembled in lucite cylinders. Others were shaft shots.

WEIGHT (lb): Phase I: Shots 3 and 4 - 100
Phase II: Shots 6, 7, 16 and 17 - 200; Shots 8 and 9 - 500; Shots 10, 11, 12, 13, 15 - 1,000; Shot 14 - 2,000

GEOLOGY:

METEOROLOGY:

TEST OBJECTIVE: Determine whether exploding an HE charge in the center of a large underground sphere would produce seismic decoupling of the resulting shock wave.

REFERENCES:

Project Cowboy, Final Report, High Explosives, Arming and Systematics, 30 June 1960, Sandia Corporation, SC-4823(RR).
Flanders, P.L., *Nuclear Geoplosics, a Sourcebook of Underground Phenomena and Effects of Nuclear Explosions, Part 3, Test Sites and Instrumentation*, May 1964, DASA-1285 (III), Stanford Research Institute.
Godfrey, C., et al. *A Theoretical and Experimental Study of Detonations in Connection with Decoupling*, November 1969, Physics International Company, DASA 2505.

SERIES: Middle North

LOCATION: Suffield (DRES), Watching Hills, Alberta, Canada

DATE: 23 July 1970 at 1100 MST

CHARGE: TNT. Sphere tangent to and above the ground surface. Lower half of charge was supported by high-strength styrofoam precut to follow the contour of the charge. Styrofoam and TNT rested on a layer of four sheets of 3/4-in plywood. Charge weights: 999,123 lb. Sphere radius, 13.46 ft.

WEIGHT (lb): 1,000,000

GEOLOGY: 5-ft surface layer of silty clay underlain by a 27-ft bed of fine silty sand. A layer of soft gray clay extends from 32 to 80 ft below ground surface and a layer of coarse sand and gravel extends from 80-100 ft. Average water table depth is 24 ft.

METEOROLOGY: Ambient pressure 13.57 psi; surface temperature 92.1°F; relative humidity 61 percent; wind at 0.5 meters 3.2 mph at 140° bright sun with 3/10 cumulus clouds scattered over whole sky.

TEST OBJECTIVE: Determine the loading and response of military systems and components when subjected to airblast and ground shock. Both surface and subsurface targets were exposed. Obtain fundamental data on high-pressure airblast, dynamics of crater formations, dust cloud characterization, and Astronaut training.

REFERENCES:

Giglio, T.L., *Middle North Series, Dial Pack Event, Project Officers Report. Fundamental Blast Studies,* 22 December 1972, Ballistic Research Laboratories, POR-6744.

Event Dial Pack Preliminary Report, 2 volumes, May 1971, DASIAC, DASA 2606.

The Defence Research Board of Canada, *Event Dial PACK Symposium Report, 2 vol,* March 1971.

DIAMOND MINE HE

SERIES: Mighty Mite

LOCATION: Nevada Test Site, Area 16-3

DATE: 4 February 1971

CHARGE: Tamped nitromethane in a spherical configuration. Placed in the Diamond Mine cavity.

WEIGHT (lb): 985

GEOLOGY: Zeolitized ash-fall tuff without bedding plants.

METEOROLOGY:

TEST OBJECTIVE: Calibration shot for Diamond Mine; measure ground velocity and acceleration to aid in the development of a stain-rate-dependent materials property model of tuff. Results to be compared with Diamond Dust and Mine Dust HE.

REFERENCES:

Davis, W.J., *Mighty Mite Series, Diamond Mine Event, Test Group Directors Final Summary Report*, 28 January 1972, Test Command, Kirtland Air Force Base, POR-6771-1.
Kratz, H.R. and Hartenbaum, B.A., *Mighty Mite Series, Diamond Mine Event, Project Officers Report, Calibration Shot Ground Motion Measurements*, 9 June 1972, Applied Theory Inc., POR-6578.
Whitener, J.E., *Mighty Mite Series, Diamond Mine Event, Technical Director's Final Summary Report*, 17 June 1974, R & D Associates, POR 6571-3.

SERIES: Diamond Ore

LOCATION: Duck Creek Inlet, adjacent to Fort Peck Reservior, Montana

DATE: October 1971

CHARGE: Water-gelled aluminized ammonium nitrate slurry.

WEIGHT (lb): 32,000 each

GEOLOGY: Bearpaw clay shale.

METEOROLOGY:

TEST OBJECTIVE: The Diamond Ore series was designed to determine the effects which different types of stemming, depths of burial, and geologic media will have on the cratering properties of a sub-surface emplaced explosive. Phase II was to develop the chemical explosive configuration required to best model a nuclear energy source, further develop fallout tracing techniques, and test simulation techniques for large-scale detonations.

REFERENCES:

Sisemore, C.J., et al, *Project Diamond Ore, Phase IIA: Close-in Measurements Program*, 28 August 1974, UCRL-51620.

Blackman, Claude A., et al, *Project Diamond Ore, Phase IIA: Effectiveness of Craters as Barriers to Mobility*, May 1973, AEWES MP M-73-6, AD-A017 726.

O'Connor, J.M., *Explosive Selection and Fallout Simulation Experiments Nuclear Cratering Device Simulation (Project Diamond Ore)*, October 1973 AEWES TR E-73-6.

DIAMOND ORE
Phases IIB and IIC

SERIES: Diamond Ore

LOCATION: Duck Creek Inlet, adjacent to Fort Peck Reservoir, Montana.

DATE: Phase IIB: October 1972; IIC: 1973

CHARGE: Aluminized ammonium nitrate slurry (AANS); TNT. Phase IIB: unstemmed 36,000-lb shot at DOB of 20 ft; five unstemmed 2,000-lb shots at DOB of 5, 10, 15, 20, and 25 ft; four 1,000-pound TNT surface detonations; also 9 unstemmed cratering shots with yield of 40 lb to 4,000 lb and DOB of 5 to 25 ft. Phase IIC: four 20,000-lb detonations at DOB of 40 ft (1 stemmed, 1 unstemmed, 1 water stemmed, and 1 partially stemmed).

WEIGHT (lb): 2,000-36,000

GEOLOGY: Bearpaw shale

METEOROLOGY:

TEST OBJECTIVE: The series was designed to determine the effects of different types of stemming on the cratering properties of a subsurface emplaced explosive. Phase II sought to develop the chemical explosive configuration required to best model a nuclear energy source, further develop fallout tracing techniques, and test simulation techniques for large-scale detonations.

REFERENCES:

O'Connor, J.M., *Environmental Impact Statement, Phase II, Project Diamond Ore*, Ft. Peck, Montana, 3 August 1972, EIS-MT-72-5068-F.
O'Connor, J. M., *Explosive Selection and Fallout Simulation Experiments, Nuclear Cratering Device Simulation (Project Diamond Ore)* October 1973, WES TR E-73-6.

pre-DICE THROW II
Events 1 and 2

SERIES: Middle North

LOCATION: White Sands Missile Range, New Mexico
Queen 15 Area

DATE: Event 1: 12 August 1975 at 1100
Event 2: 22 September 1975 at 1200

CHARGE: Event 1: 32-lb blocks of TNT stacked in a surface tangent spherical configuration.
Event 2: A combination of 50-lb ANFO sacks and loose ANFO material stacked in a hemispherical ended cylinderical configuration.

WEIGHT (lb): Event 1: 200,000
Event 2: 240,000

GEOLOGY: Brown silty clay overlying a soft gray clay. Below this is fine-to-coarse silty sand with gravel.

METEOROLOGY:

TEST OBJECTIVE: The series was designed primarily to verify blast and shock parameters for a charge selection program and to confirm the suitability of ANFO and its charge configuration as a source replacement for TNT high explosive events.

REFERENCES:

Edwards, Thomas Y. and Perry, Gerald L.E., *Middle North Series, Pre-Dice Throw II Events; Preliminary Results Report*, September 1976, POR 6904.
Jackson, A.E.,Jr. and Peterson, R.W., *Material Property Investigation for Pre-Dice Throw - I and II: Results from the Laboratory Testing Programs*, November 1976, Army Engineer Waterway Experiment Station.

DICE THROW

SERIES: Middle North

LOCATION: White Sands Missile Range, New Mexico
Giant Patriot Site

DATE: 6 October 1976 at 0800

CHARGE: Hemisphere constructed with 50-lb bags of ANFO and voids filled with loose ANFO. The initiation system consisted of seven combination pentolite/octal boosters and Reynolds RP-1 detonators. The charge was stacked on a 2-1/4-in. plywood platform tangent to the ground.

WEIGHT (lb): 1,000,000

GEOLOGY:

METEOROLOGY:

TEST OBJECTIVE: Provide a simulated nuclear blast and shock environment for target response experiments and to confirm empirical predictions and theoretical calculations for shock response of military structures, equipment and weapons systems.

REFERENCES:

Dice Throw Event, Middle North Series, Test Plan, 9 July 1976, Defense Nuclear Agency.
"Record Non-Nuclear Test Conducted at White Sands," *Albuquerque Journal*, 7 October 1976.

Note: Official documentation on DICE THROW is in preparation.

DIODE TUBE

SERIES: Miracle Play

LOCATION: Tatum Salt Dome cavity created by the Salmon Event, Hattiesburg, Mississippi.

DATE: 2 February 1969

CHARGE: Detonable gas mixture of liquid oxygen and liquid methane in a ratio of 1.97 by volume pumped into Salmon-Sterling radius cavity 2700 ft beneath the surface. The detonation was initiated at the top of the cavity rather than at the detonator.

WEIGHT (lb): 200,000

GEOLOGY: Salt dome. The top of the salt is approximately 1500 ft below the surface. Directly overlying the salt is an anhydrite-limestone caprock approximately 700 ft thick. Overlying the limestone is about 750-800 ft of sediments.

METEOROLOGY:

TEST OBJECTIVE: Test gaseous explosions as an economical detonation source for further decoupling studies. One objective was matching the equilibrium pressure minus initial pressure to that obtained from the nuclear detonation Sterling with the intent of producing seismic signals of like properties. Seismic records of Diode Tube and Sterling were compared but technical difficulties led to misfire and some loss of data.

REFERENCES:

Kelso, J.R., "Gaseous Charges and Results of First Event of Operation Miracle Play" in *AWRE Eleventh Meeting of Panel N-2*, August 1969, United Kingdom Atomic Energy Authority.

Davis, L.L. and O'Brien, L.J., *Observed Ground Motion Data, Diode Tube Event, Project Miracle Play*, 24 October 1969, NVO-1163-TM-12.

DIPOLE WEST
Shots 1 and 6

SERIES: Dipole West

LOCATION: Defence Research Establishment, Suffield, Alberta, Canada

DATE: 1: 6 July 1973 at 1430 MDT
6: 31 July 1973 at 1720 MDT

CHARGE: Shot 1: a single cast spherical charge of pentolite at 124.21 ft HOB.
Shot 6: a single cast spherical charge of TNT at 133.71 ft HOB.

WEIGHT (lb): 1: 1,080
6: 1,086

GEOLOGY: Pale grey shale and sandstone with thin coral seams near the top. The site is relatively flat. Ground surface condition hard and smooth.

METEOROLOGY: Shots 1 and 6, respectively: ambient pressure 13.3 psi and 13.49 psi; surface temperature 79.0°F and 122.0°F; relative humidity 53 and 22 percent; wind velocity and direction 15.2 at 245T and 4.2 at 290T. GZ for shot I obscured by rain clouds in area; 8/10 cumulo-nimbus clouds, 2/10 alto-cumulus. Shot 6 sky condition, 4/10 towering cumulus and 1/10 cirrostratus clouds.

TEST OBJECTIVE: To provide calibration information and data for comparisons with horizontally arrayed multiple bursts in Dipole West series related particularly to cloud rise and air blast. There were significant differences between Shots 1 and 6 attributable to height and explosive energy.

REFERENCES:

Keefer, John H. and Reisler, Ralph E., *Multiburst Environment - Simultaneous Detonations Project Dipole West*, March 1975, Ballistic Research Laboratory, BRL R 1766

SERIES: Dipole West

LOCATION: Defence Research Establishment, Suffield, Alberta, Canada

DATE:

	2	3	4	5
1973	12 July	18 July	24 July	26 July
at	0730 MDT	1050 MDT	1704 MDT	1650 MDT

CHARGE: Shots 2, 3, 4: TNT. Shot 5: Pentolite. Two cast spherical charges fired simultaneously as part of horizontally arrayed double burst series. Charge suspension heights varied from 125 ft to 134 ft with separation distances of 50, 100 and 165 ft.

WEIGHT: (lb)	2	3	4	5
	2,172	2,172	2,172	2,160

GEOLOGY: Pale grey shale and sandstone with thin coral seams near the top. The site is relatively flat. Ground surface condition hard and smooth.

METEOROLOGY:

Ambient Pressure (psi)	13.55	13.61	13.63	13.57
Surface temperature (°F)	60.7	104.2	89.4	104.2
Relative humidity (%)	42	54	54	38
Wind velocity and direction	14.3 at 315T	3.6 at 060T	210 at 310T	2.3 at 180T

TEST OBJECTIVE: Obtain information on the interaction of shock waves with a real, as contracted with an ideal, reflecting surface. Results were to be used to modify hydrodynamic airblast codes. Additionally, the fireball interaction and torus formation under double-burst conditions were to be studied as a function of separation distance and shock strength.

REFERENCES:

Keefer, John H. and Reisler, Ralph E., *Multiburst Environment-Simultaneous Detonation Project Dipole West*, March 1975, Ballistic Research Laboratory, BRL R 1766.

DIPOLE WEST
Shots 7-11

SERIES: Dipole West

LOCATION: Defence Research Establishment, Suffield, Alberta, Canada

DATE:	7	8	9	10	11
1973	4 September	17 September	22 October	2 November	8 November
at	1650 MDT	1730 MDT	1156 MDST	1400 MDST	1535 MDST

CHARGE: Two cast spherical charges of pentolite fired simultaneously as part of vertically arrayed double-burst series. HoB varied from 45 to 74 ft for the higher burst and 15 to 25 ft for the lower charges. The distance separating charges was 30 to 50 ft.

WEIGHT (lb): 2,160 each

GEOLOGY: *Pale grey shale and sandstone with thin coral seams* near the top. The site is relatively flat. Ground condition for Shots 7 through 9 was natural, hard-packed, smooth prairie soil; for Shots 10 and 11 a rough, soft absorbent surface was created by furrowing the soil out to a ground range of 230 ft. Distances between furrows and depth of furrows were 14 in.

METEOROLOGY:	7	8	9	10	11
Ambient pressure (psi)	13.59	13.52	13.49	13.69	13.68
Surface Temperature (°F)	97.0	82.5	59.8	na	2.4
Relative humidity (%)	37	31	55	81	60
Wind velocity and direction	7.9 at 330	2.5 at 150	3.8 at 245	7.2 at 030	calm

TEST OBJECTIVE: Examine shock wave interactions with real and ideal reflecting surfaces; the effect of a hard smooth surface versus that of a rough, soft surface on shock wave interaction; shock/fireball interactions and fireball growth and rise; and the effect of vertical charge orientation by comparison with horizontal arrays having the same separation distance.

REFERENCES:

Keefer, John H. and Reisler, Ralph E., *Multiburst Environment-Simultaneous Detonations Project Dipole West*, March 1975, Ballistic Research Laboratory, BRL R 1766.

SERIES: Dipole West*

LOCATION: Defence Research Establishment, Suffield, Alberta, Canada

DATE:	12	13	14	15	16
	24 Oct 74	28 Oct 74	30 Oct 74	1 Nov 74	10 Jun 75
at	1100 MDST	1200 MST	1500 MST	1200 MST	1450 MST

CHARGE: Shot 14 was a single pentolite charge. All other shots were two pentolite charges in non-simultaneous sequence with times between detonations of 0, 3, 5, and 10 milliseconds. Both were detonated at ground surface on a firm, stabilized base.

WEIGHT: (lb)	12	13	14	15	16
	432	432	216	432	432

GEOLOGY:

METEOROLOGY:	12	13	14	15	16
Wind: MPH at 2 meters:	2.1@ 297°	Calm	4.8@ 110°	6.7@ 071°	2.7@ 295°
Temperature (F):	43.3	63.0	39.8	35.7	73.2
Humidity (%):	65	67	86	68	07
Ambient pressure (mb):	939.5	914.4	928.0	929.0	936.6

TEST OBJECTIVE: Obtain information on the phenomenology of strong shock on shock, shock on fireball, and fireball flow interactions from the detonation of multiple HE charges. Compare with the AFWL HULL hydrodynamic air blast code.

REFERENCES:

Reisler, Ralph E. and Pettel, B. A., *Project Dipole West -- Multiburst Environment (Non-Simultaneous Detonations)*, September 1976, Ballistic Research Laboratories, BRL R 1921.

*Note: Shots 17-25 detonated in the summer of 1975 had not been documented prior to publication of this Guide.

DISTANT PLAIN 1

SERIES: Distant Plain

LOCATION: Suffield Experimental Station, Ralson, Alberta, Canada
Drowning Ford Range

DATE: 12 July 1966 at 1125 MST

CHARGE: Spherical TNT charge of cast 12" x 12" x 4" blocks supported on blocks of wood, all stacked on a steel platform and detonated on top of 81.3 ft tower. Diameter of sphere 9.2 ft, which placed HOB at 85.9 ft.

WEIGHT (lb): 40,000

GEOLOGY: Summer prairie over silty clay alluvium.

METEOROLOGY: Temperature: surface 96.0 F; 2 meters 77.8 F. Wind velocity and direction: .6 meter - 7.2 mph at 07°, 2 meters-10.2 mph at 80°. Humidity 46 percent; sunshine, bright. Ambient pressure: 13.74 psi at GZ; 13.69 psi at 85 ft GZ.

TEST OBJECTIVE: Record fundamental data on air blast, the flow phenomena in the mach and regular reflection region, and the air induced ground shock from a tower shot.

REFERENCES:

Operation Distant Plain Preliminary Report, December 1966, DASIAC, DASA 1876.
Reisler, R.E., et al., *Blast Measurements from the Detonation of Tower Placed 20 Tons of Spherical TNT* February 1971, Ballistic Research Laboratories, BRL MR 2089.

SERIES: Distant Plain

LOCATION: Suffield Experimental Station, Ralston, Alberta, Canada. Watching Hill Blast Range.

DATE: 18 August 1967 at 1030 MST

CHARGE: Spherical charge of 12" x 12" x 4" blocks of cast TNT supported on blocks of wood and detonated at 30 ft on a 25-ft timber tower.

WEIGHT (lb): 40,000

GEOLOGY: Summer prairie over silty clay alluvium.

METEOROLOGY: Wind velocity at 2 meters: 195° at 6.5 mph; surface temperature 108.2°F; relative humidity 42 percent; pressure 13.67 psi; bright sun and clear.

TEST OBJECTIVE: Gain data on underground phenomenology not gained on Shot 1. Shot 1A is a repeat of Shot 1.

REFERENCES:

Spackman, N., *Canadian Participation in Operation Distant Plain, Shot 1A, Layout, Survey and Meteorological Data and Details of Charge*, 13 December 1967, Suffield Memo 51/67

Reisler, R. E., et al., *Blast Measurements from the Detonations of Tower Placed 20 Tons of Spherical TNT*, February 1971, Ballistic Research Laboratories, BRL MR 2089.

DISTANT PLAIN 2A

SERIES: Distant Plain

LOCATION: Suffield Experimental Station, Ralston, Alberta, Canada
Drowning Ford Range.

DATE: 22 July 1966 at 1315 MST

CHARGE: Hemispherical balloon filled with oxygen and propane. Balloon diameter was 125 ft; it was anchored to the ground surface.

WEIGHT (lb): 40,000

GEOLOGY: Summer prairie over silty clay alluvium.

METEOROLOGY: Ambient atmosphere 13.71 psi; surface temperature 117.5 F; wind at 2 ft 3.1 mph at 135°; relative humidity 46 percent; bright sunshine.

TEST OBJECTIVE: Explore the feasibility of applying the detonable gas simulation technique to large yields for future target response tests and to compare the measured blast parameters to 20-ton TNT hemispherical charges.

REFERENCES:

Operation Distant Plain Preliminary Report, December 1966, DASIAC, DASA 1876.
Reisler, Ralph E. et al., *Airblast Measurements from the Detonation of an Explosive Gas Contained in a Hemispherical Balloon (Operation Distant Plain, Event 2A)*, July 1971, Ballistic Research Laboratories, BRL MR 2108.

SERIES: Distant Plain

LOCATION: Suffield Experimental Station, Ralston, Alberta, Canada. Drowning Ford Range

DATE: 28 July 1966 at 1245 MST

CHARGE: Spherical stacked charge of TNT, with center of charge placed at the air-ground interface. Charge initiated at the center.

WEIGHT (lb): 40,000

GEOLOGY: Summer prairie over silty clay alluvium.

METEOROLOGY: Ambient atmosphere 13.64 psi; surface temperature 101.0°F; wind at 2 ft 0.8 mph at 220°; relative humidity 42 percent; bright sunshine.

TEST OBJECTIVE: Gather more fundamental data on blast and close-in ground shock phenomena. Results to be correlated with those of Flat Top series.

REFERENCES:

Operation Distant Plain Preliminary Report, December 1966, DASIAC, DASA 1876.

Reisler, Ralph E., et al., *Air Blast Parameters From Summer and Winter 20-Ton TNT Explosion, Operation Distant Plain, Events 3 and 5*, November 1967, Ballistic Research Laboratories, BRL MR 1894.

DISTANT PLAIN 4
(Blowdown II)

SERIES: Distant Plain

LOCATION: Edson Forest, 10 miles northwest of Hinton, Alberta, Canada

DATE: 16 August 1963 at 1200

CHARGE: A hemispherical TNT charge made up of 12" x 12" x 4" 32.6-lb cast blocks. Weight 100,196 lb.

WEIGHT (lb): 100,000

GEOLOGY: Virgin stand of mixed white spruce and lodgepole pine 70 ft to 90 ft in height. Snags and dead trees were common. Both a managed forest section and a cleared section were monitored.

METEOROLOGY: Following nighttime rain, clearing until 1000 hrs; by 1200 hrs cumulus cloud cover was 6-7/10. Wind: 1.0 mph at 2M; relative humidity 55 percent; surface temperature 50°F; atmospheric pressure 12.25 psi.

TEST OBJECTIVE: Determine the effects of an explosion in a forest cover comparable to a managed European forest, with special reference to the effect on trafficability and troop movement. Ground motion was measured at three locations off the layout.

REFERENCES:

Laidlow, B.G. and Winfield, F.H., *Canadian Participation in Operation Distant Plain Shot 4 (Blowdown II), Part I. Scientific Instrumentation and Records of Shock and Blast Data*, 30 December 1966, Suffield Experimental Station, Suffield, TN 176.

Spackman, N., et al., *Canadian Participation in Operation Distant Plain (Shot 4 - Blowdown II), Part II. Description of Site, Survey, and Meteorological Data and Details of Charge*, 3 April 1967, Suffield Experimental Station, AD 398521.

SERIES: Distant Plain

LOCATION: Suffield Experimental Station, Ralston, Alberta, Canada, Drowning Ford Range.

DATE: 9 February 1967 at 1300 MST

CHARGE: 12" x 12" x 4" cast blocks of TNT stacked spherically with center of gravity at the air-frozen ground interface.

WEIGHT (lb): 40,000

GEOLOGY: Winter prairie over silty clay alluvium.

METEOROLOGY: Ambient atmosphere 13.51 psi; surface air temperature 33.2°F; wind at 2 meters 8.4 mph at 255°; relative humidity at surface 77 percent; sun bright, 4 in. of snow on prairie; 3/10 cirrus clouds.

TEST OBJECTIVE: Determine effects of a frozen ground surface on cratering, ground shock, and airblast propagation. Also determine effect of a ground snow cover on the propagation of airblast over the ground surface and into snow tunnels.

REFERENCES:

Operation Distant Plain Preliminary Report, December 1966, DASIAC, DASA 1876.

Reisler, Ralph E., et al., *Air Blast Parameters From Summer and Winter 20-Ton TNT Explosion, Operation Distant Plain, Events 3 and 5*, November 1967, Ballistic Research Laboratories, BRL MR 1894.

SERIES: Distant Plain

LOCATION: Suffield Experimental Station, Ralston, Alberta, Canada, Watching Hill Blast Range

DATE: 26 July 1967 at 1130 MST

CHARGE: Block built sphere of TNT resting tangentially to the surface on two layers of 3/4" plywood 16' x 16'. First 4 layers had wooden supports; next 10 had styrofoam supports. Average weight of each block 32.6 lb. Layers 23 to 26 inclusive used 16" x 16" x 4" blocks instead of the usual 12" x 12" x 4".

WEIGHT (lb): 200,000

GEOLOGY: Summer prairie over silty clay alluvium.

METEOROLOGY: Wind velocity at 2 meters: 040° at 4.0 mph; surface temperature 83°F; relative humidity at 4-1/2 ft: 45%; pressure 13.58 psi; light rain, sun obscured.

TEST OBJECTIVE: Investigate the effects of a spherical charge resting tangentially to the surface, with special emphasis on underground phenomenology as a preliminary to Prairie Flat 500-ton shot.

REFERENCES:

Spackman, N. *Canadian Participation in Operation Distant Plain, Shot 6, Layout, Survey and Meteorological Data and Details of Charge*, 15 December 1967, Suffield Memo 52/67.

Reisler, Ralph E., et al, *Air Blast Measurements from the Detonation of Large Spherical TNT Charges Resting on the Surface (Operation Distant Plain, Events 6A, 6)*, January 1969, Ballistic Research Laboratories, BRL MR 1995.

DISTANT PLAIN 6A*

SERIES: Distant Plain

LOCATION: Suffield Experimental Station, Ralston, Alberta, Canada, Drowning Ford Range.

DATE: 18 May 1967 at 1100

CHARGE: TNT blocks stacked spherically and positioned tangentially on the ground. The charge was supported by two thicknesses of three-quarter in. plywood blocks.

WEIGHT (lb): 40,000

GEOLOGY: Summer prairie over silty clay alluvium.

METEOROLOGY: Winds: 7.3 mph at 300°; air temperature 65.5°F; relative humidity 37%; moderate sun; ground dry; pressure 13.74 psi.

TEST OBJECTIVE: To measure and analyze the blast phenomena and to compare the results with theoretical computer calculations with data obtained on related past experiments. Determine pressure-distance relationships and crater formation for the charge configuration for Distant Plain 6.

REFERENCES:

Reisler, Ralph E., et al, *Air Blast Measurements from the Detonation of Large Spherical TNT Charges Resting on the Surface (Operation Distant Plain, Events 6A,6)*, January 1969, Ballistic Research Laboratories, BRL MR 1995

Spackman, N., *Canadian Participation in Operation Distant Plain (Shot 5a), Layout, Survey and Meteorological Data and Details of Charge*, 19 July 1967, Suffield Experimental Station, Suffield Memorandum 34/67.

*Note: Distant Plain 6A was referred to as 5A in the Canadian report.

DIVE UNDER
4 shots

SERIES: Dive Under

LOCATION: San Clemente Island, California

DATE: August 1970

CHARGE: The explosive charges of HBX-1 were suspended from a pontoon and kept in place at a DOB of 200 ft with a bridle.

WEIGHT (lb): Shot 1: 10,000
Shots 2-4: 40,000

GEOLOGY: 800-900 ft water depth with bottom consisting of a firm grey-green sand containing many small shells and fragments.

METEOROLOGY:

TEST OBJECTIVE: Underwater shock effects on a heavy hulled ship and shipboard systems, including three items of ordnance equipment. A follow-on to Sailor Hat.

REFERENCES:

Price, R.S. and Dempsey, J.B. *Operation Dive Under: Final Analysis of the Underwater Pressure-Time Data, Including the Bottom-Reflected Pulse*, 17 May 1972, Naval Ordnance Laboratory, NOLTR 72-101.

Crane, Frederick, *Operation Dive Under: The Effects of Shock on Ordnance Equipment Installed on USS Atlanta*, July 1971, Naval Underwater Systems Center, NUSC4092.

SERIES: Plowshare

LOCATION: Nevada Test Site, Buckboard Mesa, Area 18

DATE: 24 June 1964 at 0806 PDT

CHARGE: 5 separate 20-ton spherical charges of liquid nitromethane buried with their centers 58.8 ft deep and 45 ft apart. Holes were 36 in. in diameter.

WEIGHT (lb): 200,000

GEOLOGY: Basalt rock

METEOROLOGY:

TEST OBJECTIVE: Cratering experiment in basalt rock with chemical charges placed in a row. Represented the first opportunity to examine air blast from row charges. Enabled the checking of scaling validity for appreciably larger charges and in different media.

REFERENCES:

Vortman, L.J., *Comparison of Air Blast from Two Sizes of Row Charges*, October 1966, Sandia Corporation, SC-RR-66-45.

Day, J.D., *Project Dugout Deep Underground Shock Measurements*, 24 May 1965, Army Engineer Waterways Experiment Station, PNE-609F.

Spruill, Joseph L., *Project Dugout, Apparent Crater Studies*, March 1965, Army Engineer Nuclear Cratering Group, PNE-601F.

EDWARDS AF BASE
3 shots

SERIES: Edwards AF Base

LOCATION: Edwards Air Force Base, California

DATE: February 1961

CHARGE: Shots 1 and 2: block TNT detonated from 13.5 ft tower. Shot 3: surface.

WEIGHT (lb): Shot 1 and 2: 10,000
Shot 3: 500

GEOLOGY:

METEOROLOGY:

TEST OBJECTIVE: Increase the scope and reliability of the scaling factor for damage to military vehicles from sub-kiloton yields.

REFERENCES:
Long, Robert P., *High Explosive Blast Effects on 1/4-ton Trucks*, October 1964, BRL MR 1610.

SERIES: Eskimo

LOCATION: Naval Weapons Center, China Lake, California
Randsburg Wash Test Range

DATE: 8 December 1971 22 May 1973 12 June 1974 10 September 1975

CHARGE: In the first three tests the explosive was stored in a donor magazine igloo and similar earth-covered acceptor igloos exposed to the blast at various distances and layouts. For the fourth test the explosives, TNT blocks stacked in hemispherical form, were left exposed.

WEIGHT (lb):	I	II	III	IV
	200,000	24,000	350,000	37,000

GEOLOGY:

METEOROLOGY:

TEST OBJECTIVE: Analyze dynamic response of magazine headwalls to blast loadings for the purpose of establishing minimum separation distances for earth-covered, steel-arch magazines. Compare results with analytical techniques.

REFERENCES:
Reddy, Damoder P., *Dynamic Analyses of Magazine Headwalls in the Eskimo Tests*, May 1976, Agbabian Associates, R-7556-1-4182.

ESSEX* 1, PHASE 1
4 shots

SERIES: Diamond Ore

LOCATION: Fort Polk Military Reservation, Peason Ridge Artillery Range, Louisiana

DATE:	1973	12 MS - 8/23	12 MPS - 9/20	6 MS - 10/3	6 MU - 10/24
	at	1243	1115	1116	1115

CHARGE: Gelled nitromethane, centrally initiated, contained in reinforced concrete right circular cylinders with heights equal to or, for 6 MU, only slightly less than the diameters.

12 MS - 12.4 tons, 39.36 DOB, stemmed
12 MPS - 12.4 tons, 39.36 DOB, partially stemmed (open access hole)
6 MS - 12.4 tons, 19.19 DOB, stemmed
6 MU - 9.9 tons, 19.19 DOB, unstemmed

WEIGHT (lb): ~20,000 each

GEOLOGY: Gently rolling hills vegetated with tall grass and scattered colonies of trees. Sedimentary deposits of sands, silts, and clays. Water table 3 to 5 meters below the surface.

METEOROLOGY:

	Wind(mph)	Temperature
12 MS	- 4 from 210°	89°F
12 MPS	- not available	82°F
6 MS	- 3 from 225°	84°F
6 MU	- 11 from 205°	79°F

TEST OBJECTIVE: This project was a continuation of the Diamond Ore cratering program. Essex I involved cratering phenomenology, effects, and barrier assessment. Essex I was designed to develop techniques for simulating nuclear cratering detonations with a high explosive energy source.

REFERENCES:

Harvey, W.T., *Summary Report, Essex I, Phase I; Nuclear Cratering Simulation*, June 1975, DNA PR 0019.
Rooke, Allen D., *Essex - Diamond Ore Research Program: True Crater and Permanent Displacement Measurements Associated with Simulated Low-Yield Nuclear Explosions*, July 1975, DNA PR 0005.
Tami, Thomas M., *Essex-Diamond Ore Research Program: Ground Motion in the Seismic Region; Project Essex I, Phase I*, June 1975, DNA PR 0018.
Day, J. Donald, *Essex-Diamond Ore Research Program: Ground Motions in the Intermediate Range, Essex 1, Phase 1*. November 1976, DNA PR 0013.

*Effects of Subsurface Explosions

ESSEX 1, PHASE 2
4 shots

SERIES: Diamond Ore

LOCATION: Fort Polk Military Reservation, Peason Ridge Artillery Range, Louisiana.

DATE:	1974	6 MWS 6/22	3 MS 7/3	3 MU 8/10	12 MU 8/16
	at	1053	1125	1309	1337

CHARGE: Gelled nitromethane, centrally initiated, contained in reinforced concrete right-circular cylinders with heights equal to or less than diameters.

6 MWS - 42 - GJ (10-ton) at 5.84 meter (19.2 ft) DOB, water-stemmed
3 MS - 48.3 - (11.5-ton) at 3.01 meter (9.8 ft) DOB, stemmed
3 MU - 37.8 - GJ (9-ton) at 2.97 meter (9.8 ft) DOB, unstemmed
12 MU - 33.6 - GJ (8-ton) at 11.97 meters (39.4 ft) DOB, stemmed

WEIGHT (lb): 20,000 (TNT equivalent)

GEOLOGY: Layered system of sedimentary sands, silts, and clays, with a water table at or above the charge elevation. Gently rolling hills vegetated with tall grass and scattered colonies of trees.

METEOROLOGY:
6 MWS - Wind 4.5 m/sec from 225°
3 MS - Wind 5.8 m/sec from 200°
3 MU - Wind 3.8 m/sec from 196°
12 MU - Wind 2.8 m/sec from 220°

TEST OBJECTIVE: Fully evaluate the range of possible detonation geometries in the same medium and for the same purposes as Essex, Phase I. Included in the field tests were experiments for the ESSEX V and ESSEX VI programs to study damage effects on underground structures and various types of airfields.

REFERENCES:

Wagner, R.L., *ESSEX-DIAMOND ORE Research Program; Test Execution Report, Essex 1, Phase 2: Nuclear Cratering Device Simulation*, September 1976, U.S. Army Waterways Experiment Station, DNA PR 0025.

True Cratering and Permanent Displacement Measurements for Simulated Low-Yield Nuclear Explosions, Phase 2, February 1976, U.S. Army Engineer Waterways Experiment Station, DNA PR 0012.

Vortman, L.J., *Results of Airblast Measurements Project Essex 1, Phase 2*, February 1976, Sandia Laboratories SAND 75-0274.

ESSEX 1, PHASE 3

SERIES: Diamond Ore

LOCATION: Fort Polk Military Reservation (Peason Ridge Range), Louisiana

DATE: 31 October 1975

CHARGE: Sand-contaminated nitromethane. Depth to the center of the charge was 19.19 ft (5.85 m). There was a 165 mm diameter open hole from the charge to the surface.

WEIGHT (lb): 20,000

GEOLOGY: Sedimentary deposits of sands, silts and clays.

METEOROLOGY:

TEST OBJECTIVE: Simulate an earth-penetrating nuclear warhead with a low-yield, subsurface high explosive charge. Airblast and cratering effects were investigated.

REFERENCES:

Vortman, Luke J., et al, *Results of Airblast and Temperature Measurements, Project Essex I, Phase 3*, January 1977, Sandia Laboratories, SAND76-0531.

SERIES: Ferris Wheel

LOCATION: Nevada Test Site, Area 9, Banded Mountain

DATE: 24 June 1964 at 0930 PST

CHARGE: 1126 cast 35-lb TNT blocks stacked in near spherical array; charge center of gravity at ground surface; charge radius ∿1.4 meters. The blocks were emplaced on a leveling limestone-matching grout after removing a thin overburden of alluvium and broken rock. Shot was center detonated.

WEIGHT (lb): 40,000

GEOLOGY: Limestone, heavily bedded with a dip of 40 degrees. Limestone was covered with a thin layer of alluvial detritus.

METEOROLOGY: Clear and mild, with surface winds of 11 knots from the northeast (30° true azimuth); temperature 20.9°C; pressure 12.6 psi.

TEST OBJECTIVE: Furnish information on cratering and airblast. Collect information on ground shock outside of the crater, especially directly beneath the crater; symmetry of ground shock round the crater; ground shock induced by air blast; crater dimensions; crater ejecta; high pressure developed near TNT/soil interface.

REFERENCES:

Flat Top Event I, II, III: Technical/Operational Plan, 23 January 1964, Defense Atomic Support Agency.
Davis, L.K. *Ferris Wheel Series Flat Top Event, Crater Measurements*, 9 August 1966, Army Engineer Waterways Experiment Station, POR-3008.
Bass, R.C. and Hawk, H.L., *Ferris Wheel Series, Flat Top I Event, Close-in Shock Studies*, 19 October 1965, Sandia Corp. POR 3005.
Merritt, M.L., *Ferris Wheel Series, Air Vent/Flat Top Events, Project Officers Report, Scientific Directors Summary*, 27 September 1968, POR-3000.

FLAT TOP II

SERIES: Ferris Wheel

LOCATION: Nevada Test Site, Area 5, Frenchman's Flat

DATE: 17 February 1964 at 1130 PST

CHARGE: 35-lb blocks of TNT stacked in near spherical array; charge center of gravity at ground surface. The space between the explosive and the native soil was filled with alluvium screened to remove coarse material.

WEIGHT (lb): 40,000

GEOLOGY: Playa alluvium (homogeneous, inorganic lacustrine silt). Scarce vegetation.

METEOROLOGY: Clear and cool, with a 2-knot surface wind from the northwest (330° true azimuth); temperature 3.0°C; pressure 13.25 psi.

TEST OBJECTIVE: Collect information on ground shock outside of the crater, especially directly beneath the crater; symmetry of ground shock round the crater; ground shock induced by air blast; crater dimensions; crater ejecta; high pressure developed near TNT/soil interface.

REFERENCES:

Davis, L.K., *Ferris Wheel Series Flat Top Event, Crater Measurements*, 9 August 1966, Army Engineer Waterways Experiment Station, POR-3008.
Ahlers, E.B., *Ferris Wheel Series Flat Top Event, Crater Ejecta Studies*, 21 November 1966, Illinois Institute of Technology, POR-3006.
Merritt, M.L., *Ferris Wheel Series, Air Vent/Flat Top Events, Project Officers Report, Scientific Directors Summary*, 27 September 1968, POR-3000.

SERIES: Ferris Wheel

LOCATION: Nevada Test Site, Area 5, Frenchman's Flat

DATE: 24 March 1964 at 1045 PST

CHARGE: 35-lb blocks of TNT stacked in near spherical array; charge center of gravity at ground surface. The original soil was tamped back around each layer of HE.

WEIGHT (lb): 40,000

GEOLOGY: Playa alluvium (homogeneous, inorganic lacustrine silt). Scarce vegetation.

METEOROLOGY: Cool and overcast, with surface winds of 9 knots from the southwest (240° true azimuth); temperature 9.0°C; pressure 13.05 psi.

TEST OBJECTIVE: Collect information on ground shock outside of the crater, especially directly beneath the crater; symmetry of ground shock round the crater; ground shock induced by air blast; crater dimensions; crater ejecta; high pressure developed near TNT/soil interface.

REFERENCES:

Davis, L.K., *Ferris Wheel Series Flat Top Event, Crater Measurements*, 9 August 1966, Army Engineer Waterways Experiment Station, POR-3008.
Ahlers, E.B., *Ferris Wheel Series Flat Top Event, Crater Ejecta Studies*, 21 November 1966, Illinois Institute of Technology, POR-3006.
Merritt, M.L., *Ferris Wheel Series, Air Vent/Flat Top Events, Project Officers Report, Scientific Directors Summary*, 27 September 1968, POR-3000.

pre-GONDOLA I
Seismic Site Calibration
Series (4)

SERIES: Plowshare

LOCATION: Valley County, near Fort Peck Reservoir, 18 miles south of Glasgow, Montana

DATE:	June 1966	6/20	6/21	6/22	6/23
	at MST	0845	0811	0805	0837

CHARGE: Nitromethane contained in a spherical cavity. DOB varied from 12.2 to 23.3 ft.

WEIGHT (lb): 1,000 each

GEOLOGY: Bearpaw Shale, a highly compacted, uncemented clay-shale of Cretaceous age. Judith River formation underlies the shale at ∿900 ft.

METEOROLOGY:

TEST OBJECTIVE: Confirm site suitability, assist in seismic site calibration, and provide preliminary information for the design of the Pre-Gondola I experiment.

REFERENCES:

Kurtz, M.J., Jr., *Project Pre-Gondola I, Technical Director's Summary Report*, 12 January 1968, Army Engineer Nuclear Cratering Group, PNE-1102.

pre-GONDOLA I
Shots A,B,C,D

SERIES: Plowshare

LOCATION: Valley County, near Fort Peck Reservoir, 18 miles south of Glasgow, Montana

DATE:

	A	B	C	D
1966	10/25	10/28	11/1	11/4
at MST	1000	1200	1000	1000

CHARGE: Nitromethane contained in a mined spherical cavity ∿10 ft in diameter and center-detonated with a booster charge. DOB varied from 42.49 to 56.87 ft.

WEIGHT (lb):	A	B	C	D
	40,700	38,720	39,240	40,480

GEOLOGY: Bearpaw Shale, a highly compacted, uncemented slay shale of Cretaceous age. Judith River formation underlies the shale at ∿900 ft. Ground water is about 6 ft beneath the surface for A and B, 15 ft for C and D.

METEOROLOGY:

TEST OBJECTIVE: Calibrate the project site with respect to its cratering characteristics and provide a basis for design of proposed 140-ton Pre-Gondola II and the Pre-Gondola III row-charge cratering detonations in the same medium. Evaluate DOB effect on seismic energy coupled into the ground, yield scaling assumptions, propagation characteristics, structural response in the vicinity, effect of seismic loading on embankments, and development of basis for prediction of ground motions from higher yield detonations. Also cloud development studies.

REFERENCES:

Kurtz, M.K., Jr., *Project Pre-Gondola I Technical Directors Summary Report*, 12 January 1968, Army Engineer Nuclear Cratering Group, PNE-1102.
Kurtz, M.K., Jr., *A Report of the Scope and Preliminary Results of Project Pre-Gondola I*, 9 December 1966, Army Engineer Nuclear Cratering Group.

pre-GONDOLA II
Shots E,F,G,H,I

SERIES: Plowshare

LOCATION: Adjacent to Fort Peck Reservoir, Fort Peck, Valley County, Montana

DATE: 28 June 1967 at 0800 MDT

CHARGE: Nitromethane five-charge, row detonation with DOB from 48.8 to 59.9 ft, placed in a mined spherical cavity and center-detonated. Spacing between all charges was 80 ft.

WEIGHT:	E	F	G	H	I	
(lb)	77,220	39,400	39,100	79,120	40,000	(274,840)

GEOLOGY: Bearpaw Shale of late Cretaceous Age with Bentonite seams a few inches thick at irregular intervals of a few feet to 30 feet. Water table is 10 to 20 ft deep.

METEOROLOGY: Sky condition 1/10 altocumulus clouds at 8000 ft; visibility better than 51 miles; surface temperature 65°F; dew point 50°F; relative humidity 68 percent; surface wind 325° at 10 mph.

TEST OBJECTIVE: Gain row-charge cratering experience in a wet, weak clay shale medium, and test techniques for connecting a row-charge crater to an existing crater, as well as for overexcavating to accept throwout from a follow-on connecting row-charge crater. To determine the extent of airblast, ground motion, and cloud development and to develop predictive capability. Included fish damage studies.

REFERENCES:
Keefer, J.M., W.F. Jackson and D.P. Lefevre, *Project Pre-Gondola II Summary Report*, February 1971, U.S. Corps of Engineers, Nuclear Cratering Group, PNE 1112.

pre-GONDOLA III,
Phase I

SERIES: Plowshare

LOCATION: Duck Creek Inlet of Fort Peck Reservoir, Valley County, Montana, 18 miles south of Glasgow, Montana

DATE: 25 September 1968 (1st pass), 2 October 1968 (2nd pass)
at 0900 MDT at 1045 MDT

CHARGE: Three parallel rows containing seven 2000-lb charges of nitromethane. Two outside rows were detonated as the first pass, and the center row was detonated as the second pass. A series of calibration shots preceded Phase I array. Phase I outside rows DOB was 19.5 ft; row separation DOB 59.4 ft. Phase I nitromethane was contained in 1/8-inch thick, 45-inch-diameter aluminum spheres. The charges were center detonated.

WEIGHT (lb): 42,000 in a 3-row, 2-pass array.

GEOLOGY: Bearpaw Shale modified in the site area by a dendritic pattern of shallow gullies. The massively bedded clay shale contains thin bentonite layers and scattered concretions. Groundwater ranges from near surface to 100 ft.

METEOROLOGY:	Temp.	Dew Point	Rel. Humidity	Wind	Sur. Pressure
First pass:	59°F	45°F	60%	270°/10 kts	932.0 mb
Second pass:	46°F	32°F	58%	290°/17 kts	939.7 mb

TEST OBJECTIVE: To test a triple-row array detonated in two stages as a means of explosively excavating a linear crater in wet clay shale with flat side slopes. Programs included measurement of the apparent crater, surface-motion analysis, cloud development studies, and airblast measurements.

REFERENCES:

Cress, J.P., et al, *Pre-Gondola III, Phase I Summary Report*, April 1970, Army Engineer Nuclear Cratering Group, PNE-1114.

pre-GONDOLA III
Phase II, M-S

SERIES: Plowshare

LOCATION: Duck Creek Inlet of Fort Peck Reservoir, Valley County, Montana.

DATE: 30 October 1968 at 1000 MDT

CHARGE: Seven 60,000-lb charges of liquid explosive nitromethane were placed in a straight extension of the centerline of the Pre-Gondola II crater. All seven charges were buried at 2210 ft. MSL. Horizontal spacing between charges was 86 ft except for the two spaces separating the 3 most distant charges, the latter being 52 ft. Charges were placed in mined spherical cavities, lined with pneumatically applied mortar and scaled. Access shafts were stemmed.

WEIGHT (lb): 420,000 (seven 60,000-lb charges)

GEOLOGY: Bearpaw shale of the late Cretaceous age. Contains thin-bentonite layers and scattered concretions.

METEOROLOGY: Surface wind: 300°; pressure 919 mb; temperature 15.8°C; dew point 8.3°C; relative humidity 38 percent.

TEST OBJECTIVE: Test a connecting row charge in which the resulting row-crater would connect with an existing row-crater; also determine row crater characteristics for a given charge spacing and burial depth in a wet clay-shale medium, and the production of an excavation which would accommodate a specified navigation prism. Included measurement of crater, surface motion, airblast, cloud development, seismic and structural responses.

REFERENCES:

Lattery, J.E., *Project Pre-Gondola III, Phase II. Summary Report: Connecting Row-Crater Experiment*, March 1971, Army Engineer Nuclear Cratering Group, AD 735 726.

HARD PAN I-1, I-2A, I-2B, I-3
(4 major events, 13 calibration events)

SERIES: Hard Pan I*

LOCATION: Trading Post, Linn County, Kansas

DATE: 24 October 1974 - 4 December 1975

CHARGE: Ammonium nitrate slurry or PETN. Event I-1: An axisymmetric silo-type structure was subjected to the blast environment generated by an octagonal high explosive simulation technique (HEST) simulator. The cavity depth was three ft; density of explosive loading, 0.318 lb of PETN per ft^3; and surcharge loading, 500 lb per ft^2 or approximately 4.5 ft depth, all calculated to yield an overpressure environment similar to that at the 1200 psi range from the detonation of a 125 KT nuclear device. A three dimensional fishnet weave of detonating cord was installed in the cavity and detonation of the explosive was simultaneous at the three elevations down the center of the array.
Event I-2A: A berm loaded explosive simulation technique (BLEST) in a HEST cavity, using 1137 individual explosive charges totaling 30.9 tons placed at depths of 8.35 and 6.63 ft below the surface. Each charge consisted of 50 or 100 lb of ammonium nitrate slurry. The BLEST field encompassed an area of approximately 50,000 ft^2.
Event 1-2B: Similar to 2A with reduction from 30.9 tons to 16.1 tons with a square rather than rectangular HEST cavity.
Event 1-3: AN slurry of approximately 95 tons was planned.
Calibration Tests: To range from 50 to 5000 lb AN slurry, with one test of 2600-lb PETN.

WEIGHT:
(lb)

GEOLOGY: Unglaciated claypan prairie and prairie sandstone.

METEOROLOGY:

TEST OBJECTIVE: Obtain empirical data on the response of buried facilities in a geology of a soft clay layer over a shallow competent rock layer. Evaluate prediction techniques and develop facility subsystem response predictions.

REFERENCES:
Doran, J., *Hard Pan I Test Series and Instrumentation Plans, Volume I, Test Plan*, December 1975, Air Force Weapons Laboratory, AFWL-TR-75-249-Vol 1, *Hard Pan I Test Series Design and Construction of Test Facilities*, June 1976, Civil/Nuclear Systems Corporation, AFWL-TR-76-60.

*Documentation of test results is in preparation.

HASTINGS 11-14, 24

SERIES: Hastings

LOCATION: Naval Ammunition Depot, Hastings, Nebraska

DATE: 10-20 May 1965

CHARGE: Spherical cyclotol; C-4; PBX 9404. The five open air tests used 2-ft thick sandbag walls 6 ft high without plywood facing; cell width 6 ft. Acceptor charges were 100-lb spheres of cyclotol in their aluminum casings. Four igloo (26 x 40 ft) tests used various barricade configurations; in 2 of the 4 tests the donor charge was 108 lb; 2 were less than 100 lb. 13 igloo tests used a single sandbag dividing wall configuration; 9 of the 13 donor charges were from 100 to 500 lb; weapons were used for both donors and acceptors. Four tests were of MK 48 weapons in shipping containers.

WEIGHT (lb): 96-515

GEOLOGY:

METEOROLOGY:

TEST OBJECTIVE: Determine the effects of sand dividing walls on detonation propagation both in enclosed structures and in the open air. The overall goal was to establish safety criteria for the storage of plutonium bearing weapons.

REFERENCES:

Salmon, Martin A., *Safety Criteria for Weapon Storage*, 30 November 1966, IIT Research Institute, DASA-1894.

Blum, Robert W., *Final Report on Fourth Series of DASA Weapon Propagation Tests*, DASA 1661.

SERIES: HOB

LOCATION: Suffield Experimental Station, Ralston, Alberta, Canada

DATE: 16 September through 27 November 1969 at 12:30 MST to 1330 MST

CHARGE: TNT for 10 events; gelled slurry for 2 events. Spherical charges were cast in one piece and suspended at various heights above the ground ranging from 5.2 ft to 72.0 ft.

WEIGHT (lb): 1,000 each

GEOLOGY: Ground zero surface was weather-proofed and insofar as possible made capable of withstanding erosive effects of the blast wave. Area was level and flat.

METEOROLOGY:

TEST OBJECTIVE: To make basic measurements of the airblast parameters surrounding an air-burst explosion, with particular attention to the region of airblast enhancement caused by the reflection of the blast wave from the surface beneath the charge.

REFERENCES:

Anderson, J.H.B., *1969 1000-lb Airburst Series: Pressure-Time and Time-of-Arrival Results*, August 1974, Defence Research Establishment Suffield, No. 4873.
Anderson, J.H.B., *1969 1000-lb Airburst Trials: Operations Report*, August 1970, Defence Research Establishment Suffield, STN 272.
Reisler, Ralph E., et al, *Airblast Data from Height-of-Burst Studies in Canada, Volume 1: HOB 5.4 to 71.9 Feet*, December 1976, Ballistic Research Laboratories, BRL-R-1950.

HOBO
4 shots

SERIES: Plowshare

LOCATION: Nevada Test Site, Rainier Mesa, U12e tunnel

DATE:	1	2a	3	4
1960	3/20	3/27	4/3	4/10
at	1530	2102	1402	2000

CHARGE: TNT, with pelletol primers. Essentially cylindrical and closely tamped at

DOB (ft):	1	2a	3	4
	1040	1010	240	1037

WEIGHT (lb):	1	2a	3	4
	103¼	973	967-3/4	516

GEOLOGY: Tuff

METEOROLOGY:

TEST OBJECTIVE: To compare with results from Project Cowboy tests in salt mines as an aid in evaluation of the decoupling effect and to study the effect of variation of overburden stress on the propagation of energy.

REFERENCES:

Flanders, P.L., *Nuclear Geoplosics, a Sourcebook of Underground Phenomena and Effects of Nuclear Explosions, Part 3, Test Sites and Instrumentation*, May 1964, Stanford Research Institute, DASA-1285 (III).

Swift, L.M., and Wells, W.M., *Close-in Earth Motions, Project Hobo*, Stanford Research Institute, 28 March 1961.

SERIES: Miracle Play

LOCATION: Tatum Salt Dome, Hattiesburg, Mississippi (Salmon/Sterling cavity)

DATE: 19 April 1970 at 1245 CST

CHARGE: Detonable gas mixture of methane and oxygen pumped into Salmon/Sterling cavity 2700 ft beneath the surface. The detonation was initiated by lightening; therefore limited data was acquired.

WEIGHT (lb): 630,000

GEOLOGY: Salt dome

METEOROLOGY:

TEST OBJECTIVE: Simulation of blast effects of contained, underground nuclear explosions in cavities and measurement of reduction in decoupling caused by overdriving a cavity.

REFERENCES:

Davis, Walter J., *Miracle Play Technical and Operation Plan*, October 1968, Defense Atomic Support Agency.
Private correspondence with W. Alfonte of DASIAC (Washington), 9 July 1976.

HYDRA IIA
13 shots

SERIES: Hydra

LOCATION: San Clemente Island, California

DATE: June - October 1961

CHARGE: Uncased, spherical charges of HBX-1 68-in. in diameter. DOB underwater 2.2 to 140 ft to charge center. A three-buoy framework supported each charge in the water.

WEIGHT (lb): 10,000 each (gives bubble radius equivalent to 18,000 lb TNT charge)

GEOLOGY:

METEOROLOGY: Various: temperature from 67°F to 76°F; relative humidity from 59 percent to 96 percent; surface wind from calm to 16 kts; wind direction 220° to 315°.

TEST OBJECTIVE: Determine characteristics and measure the dimensions of the visible above-surface phenomena. Relate effects produced by chemical explosives to those produced by nuclear weapons.

REFERENCES:

Perkins, W.W., *Hydra Program, Hydra II Series, the Above-Surface Phenomena Created by 10,000-Pound Underwater Detonations*, 28 October 1963, U.S. Naval Radiological Defense Laboratory, DASA 1443.

Egeberg, L.E., *Hydra Program, Hydra IIA Series, Design, Fabrication and Handling of 10,000-lb Spherical, Uncased High-Explosive Charges*, 3 October 1963, U.S. Naval Radiological Defense Laboratory, DASA 1454.

IGLOO
3rd test

SERIES: Igloo - ADC

LOCATION: Naval Ordnance Test Station, China Lake, California, Victor Range, B Site

DATE: 4 April 1963 at 1421 PST

CHARGE: Three Genie MB-1 missiles with 325 lb of rocket propellant in each missile were placed on wheeled wooden stands, 24 inches off the floor, with the nosecone pointed at and three inches from the back wall of the donor igloo. The donor and three acceptor igloos were under one continuous, two-foot-thick earth cover. Each acceptor igloo contained one missile plus two mock-up missiles with a spherical warhead.

WEIGHT (lb): 300

GEOLOGY:

METEOROLOGY: Surface wind 210° at 4.0 kts.

TEST OBJECTIVE: Evaluate design and emplacement of igloos; acquire pressure and acceleration data resulting from detonation; acquire fallout data. Fallout test is designated Operation Side Show. Information to be applied to Operation Roller Coaster.

REFERENCES:

Miller, P.H. and Boyer, R.E., *Report of ADC Igloo Complex Test*, 24 April 1963, U.S. Naval Ordnance Test Station, IDP-1560.

IGLOO
Series A-14 tests
Series B-28 tests
Series C-11 tests

SERIES: Igloo

LOCATION: IITRI Explosive Test Facility, La Porte, Indiana

DATE: 12 May 1969 to 30 June 1970

CHARGE: C-4 was pressed into molds made of a split aluminum body with a hemispherical cavity and a flat-ended steel ram. Each charge was made up of two spheres formed in one of these molds. Center of gravity was located at the center of the donor cell by placing the charge on a cardboard standoff. Igloos were 1/10 the scale models. Three comparable igloo configurations were used. Cells in any row were in a rectangular or herringbone array.

WEIGHT (lb): 0.1-0.3-and 0.5-1b C-4 which converts to 100-, 300-, 500-1b TNT equivalent.

GEOLOGY:

METEOROLOGY:

TEST OBJECTIVE: Determine the influence of igloo and weapon storage cell geometry on the blast hazard created by the accidental detonation of the high explosive content of one cell.

REFERENCES:
Wiedermann, A.H., *Airblast in Subdivided Storage Igloos*, December 1970, ITT Research Institute, DASA 2598.

IGLOO
Phase I-52 tests
Phase II-42 tests

SERIES: Igloo

LOCATION: IITRI Explosive Test Facility, La Porte, Indiana

DATE: 18 February 1971 to 18 November 1971

CHARGE: C-4 was pressed into molds of a split aluminum body with a hemispherical cavity and a flat-ended steel ram. Charges were placed on cylindrical cardboard standoffs so that the center of gravity was located at the center of the donor cell. Roof and no-roof shots were grouped for ease of testing. 1R1 through 1R47 and 2R1 through 2R30 were roofed tests; the remainder were no-roof models.

WEIGHT (lb): 0.1-and 0.2-lb C-4, which converts to 125-and 250-lb TNT equivalent.

GEOLOGY:

METEOROLOGY:

TEST OBJECTIVE: Determine the effect of one igloo or weapon storage cell geometry on the blast hazard created by the accidental detonation of the high explosive content of one cell. Model studies were one-tenth scale.

REFERENCES:
Anderson, D.C., *Airblast in a Subdivided Storage Igloo*, May 1972, IIT Research Institute, DNA 2822F.

IITRI 1968
3 shots

SERIES: IITRI

LOCATION: Off Coast of Southern California

DATE:	Shot 1	Shot 2	Shot 3
	16 February 1968	21 February 1968	6 September 1968
at	1801:52.99	2332:08.35	

CHARGE: Slurry type explosives in containers. Explosive bodies were launched from a ship with delayed sinking to permit the vessel to reach a safe standoff distance. Vehicle attitude was essentially vertical. Shot 1 detonation depth 1,825 ft; Shot 2, 3,025 ft; Shot 3, 3,100 ft.

WEIGHT (lb): Shots 1 and 2: 24,000-26,000 (TNT equivalent). Shot 3: 62,000 lb (TNT equivalent).

GEOLOGY:

METEOROLOGY:

TEST OBJECTIVE: Obtain design information for use in the development of charges in the fractional kiloton range for use at sea as seismic sources.

REFERENCES:

Hecht, Richard J., et al, *IITRI 10-Ton 1968 Shot Series, Technical Progress Report No. 20*, 15 July 1068, Underwater Systems, Inc.
Weinstein, M.S., *Initial Study of Hydroacoustic Reverberation from Large Underwater Detonations*, 8 October 1974, AD C000880.

SERIES: Jangle

LOCATION: Nevada Test Site, Upper Yucca Flat, Area 10

DATE:	HE-1	HE-2	HE-3	HE-4
	8/25/51	9/3/51	9/15/51	9/9/51
at PST	0915	0900	0840	0940

CHARGE: 100-lb TNT blocks stacked spherically. HE-1 and HE-2 charge depth (1.9 and 4.7 ft, respectively) was such that the top of the charge was flush with the ground surface. Charge depth for HE-3 was 6.9 ft, with the top of the sphere 5.0 ft from ground surface. On HE-4 the bottom of the sphere was flush with the ground surface. Charge depth was -1.9 ft.

WEIGHT (lb):	HE-1	HE-2	HE-3	HE-4
	2,560	40,000	2,560	2,560

GEOLOGY: Alluvium. Soil consisted of extremely fine, powder-like sand mixed with gravel. Below the surface were streaks of caliche. Subsurface soil was tightly packed, very dry, and extremely porous. Bedrock was at a depth greater than 1,000 ft. No water table.

METEOROLOGY:

TEST OBJECTIVE: Provide information for scaled predictions for shallow underground and surface nuclear tests. Obtain additional information on air-earth coupling as a function of charge depth. Obtain additional information on attenuation characteristics, wave forms, and scale and model laws.

REFERENCES:

Doll, E.F. and V. Salmon, *Operation Jangle, Scaled HE Tests*, April 1952, Stanford Research Institute, WT-377.
Campbell, Donald C., *Operation Jangle, Some HE Tests and Observations on Craters and Base Surges*, 1 November 1951, Armed Forces Special Weapons Project, WT-410.

JANGLE HE 5 - HE 10

SERIES: Jangle

LOCATION: Nevada Test Site, Frenchman Flat, Area 5.

DATE:

	5	6	7	8	9	10
1951	9/30	10/2	10/4	10/13	10/14	10/14
at PST	0800	0800	0700	0700	0705	1130

CHARGE:

5	6	7	8	9	10
TNT	TNT	TNT	TNT and Pentolite	TNT and Pentolite	TNT and Pentolite

Spherical charge TNT, built of 1-,5-,20-and 100-pound blocks with a vertical dimension of 20 inches, were used for HE-5,6,7. TNT and pentolite charges, made up of 2 hemispheres with diameters of 17-3/4 inches, were used for HE-8,9,10. Depth of center of gravity 10 to 36 in.

WEIGHT (lb):

5	6	7	8	9	10
2,560	2,560	2,560	216 TNT 177 Pent.	216 TNT 177 Pent.	216 TNT 177 Pent.

GEOLOGY: Powdery sand mixed with some gravel. Rocks and boulders.

METEOROLOGY:

	5	6	7	8	9	10
Humidity (%)	51	51	46	51	62	55
Wind Direction °/Velocity mph	Calm	180/4	Calm	140.3	320/7	090/3
Temperature °F	56	54	56	56	48	69

TEST OBJECTIVE: Extend base surge and cratering phenomena studies of HE-1 through HE-4. Determine ground activity differences between TNT and pentolite explosions.

REFERENCES:

Campbell, Donald C., *Operation Jangle, Some HE tests and Observations on Craters and Base Surges*, 1 November 1951, Armed Forces Special Weapons Project, WT-410.

LITTLE DITCH
10 shots

SERIES: Plowshare

LOCATION: Albuquerque, New Mexico

DATE: 8 June 1960 - 8 August 1960

CHARGE: Row charges of TNT with 6-lb 50-50 pentolite boosters. DOB 3.17 to 12.7 ft.

WEIGHT (lb): 256 each

GEOLOGY: Albuquerque fan-delta alluvium.

METEOROLOGY:

TEST OBJECTIVE: Determine the maximum spacing at which a uniform channel would result as a function of DOB of charges in a row and to define, for spacings greater than that which would give a uniform channel, the ratios of minimum crater dimensions to maximum crater dimensions as a function of depth of burst.

REFERENCES:

Vortman, L.J., *The Effect of Row Charge Spacing and Depth on Crater Dimensions*, November 1963, Sandia Corporation, SC-4730 (RR).

MACEX AND MACEX-1

SERIES: MACEX (Mass Accountability Experiment)

LOCATION: McCormick Ranch Test Site, 7 miles south of Kirtland Air Force Base, Albuquerque, New Mexico.

DATE: 19 May 1971 - MACEX
1 June 1971 - MACEX 1

CHARGE: Cast TNT sphere placed surface tangent to ground (similar to Middle Gust 1 calibration event). Sphere was 1.33 ft in radius and contained a 10-inch diameter booster charge of pentolite.

WEIGHT (lb): 1,000 each

GEOLOGY: Playa with relatively homogeneous subsurface conditions.

METEOROLOGY: No perceptible wind.

TEST OBJECTIVE: Expand PLEX results for tangent above ground configuration to a higher yield and obtain cratering data in playa for comparison with standardized 1000-lb data base.

REFERENCES:

Terlecky, Peter M., Jr., *Crater and Mass Data for High-Explosive Cratering in Playa*, January 1964, Air Force Weapons Laboratory, AFWL-7R-73-269.

MIDDLE COURSE I
B10 - B15

SERIES: Middle Course

LOCATION: Trinidad, Colorado (Longs Canyon)

DATE: 5 October 1970 to 9 October 1970 at 1100 to 1515 MDT

CHARGE: AANS (TD-2) pumped into spun aluminum 44-in. diameter charge containers and gelled for B10 thru B14. B15 was a cylindrical AANS charge placed in a 36-in. diameter hold at a DOB of 20.9 ft. B10 HOB 3.8 ft; B11 HOB 1.9 ft; B12 was a surface detonation. B13 DOB 1.9 ft; B14 DOB 20.9 ft stemmed with concrete grout.

WEIGHT (lb): 2,000 each

GEOLOGY: Vermejo formation of Late Cretaceous Age (interbedded grey to black, carbonaceous, coally, and silty shale, buff, grey, and grey-green arkosic sandstone, grey and dark-grey siltstone, and coal.

METEOROLOGY:

	B10	B11	B12	B13	B14	B15
Temperature, °F:	32	37	69	73	44	49
Wind, mph:	NE 10	NE 13	N 0-5	W-12	NE 13	N NE 7
Weather:	Clear	Cloudy	Clear	Clear	Clear	Partial clouds

TEST OBJECTIVE: Provide experimental data for military applications of cratering and to combine these data with data from Project Trinidad to provide a complete set of scaled cratering curves for the sandstone medium.

REFERENCES:

Fitchett, Donald J., *Middle Course I Cratering Series*, June 1971, Army Engineer Nuclear Cratering Group, NCG TR-35.

MIDDLE COURSE II
M1-M16

SERIES: Middle Course

LOCATION: Two miles west of Trinidad, Colorado. Tests M1 and M2 at Long Canyon. Tests M3 through M16 at Frisco Canyon.

DATE: 7 September 1971 through 31 September 1971 from 0945 to 1011.

CHARGE: Sixteen aluminized ammonium nitrate slurry (TD-2) charges were 36 in. high and 36 in. in diameter, placed at the bottom of a 36-in. diameter hold. Burial depths were to charge center. Tests M3 to M7 were stemmed with water-filled pliofilm bags; M-31 was pit run gravel stemmed, and M-16 was soil and concrete stemmed with a 4-in. unstemmed hold from explosive to surface. Other tests unstemmed. DOBs varied from 4 to 35 feet.

WEIGHT (lb): 2,000 each (TNT equivalent)

GEOLOGY: Trinidad sandstone of the Late Cretaceous Age. Consists of buff and light grey sandstone with thin interbeds of grey sandy shale. Overburden is very clayey soil.

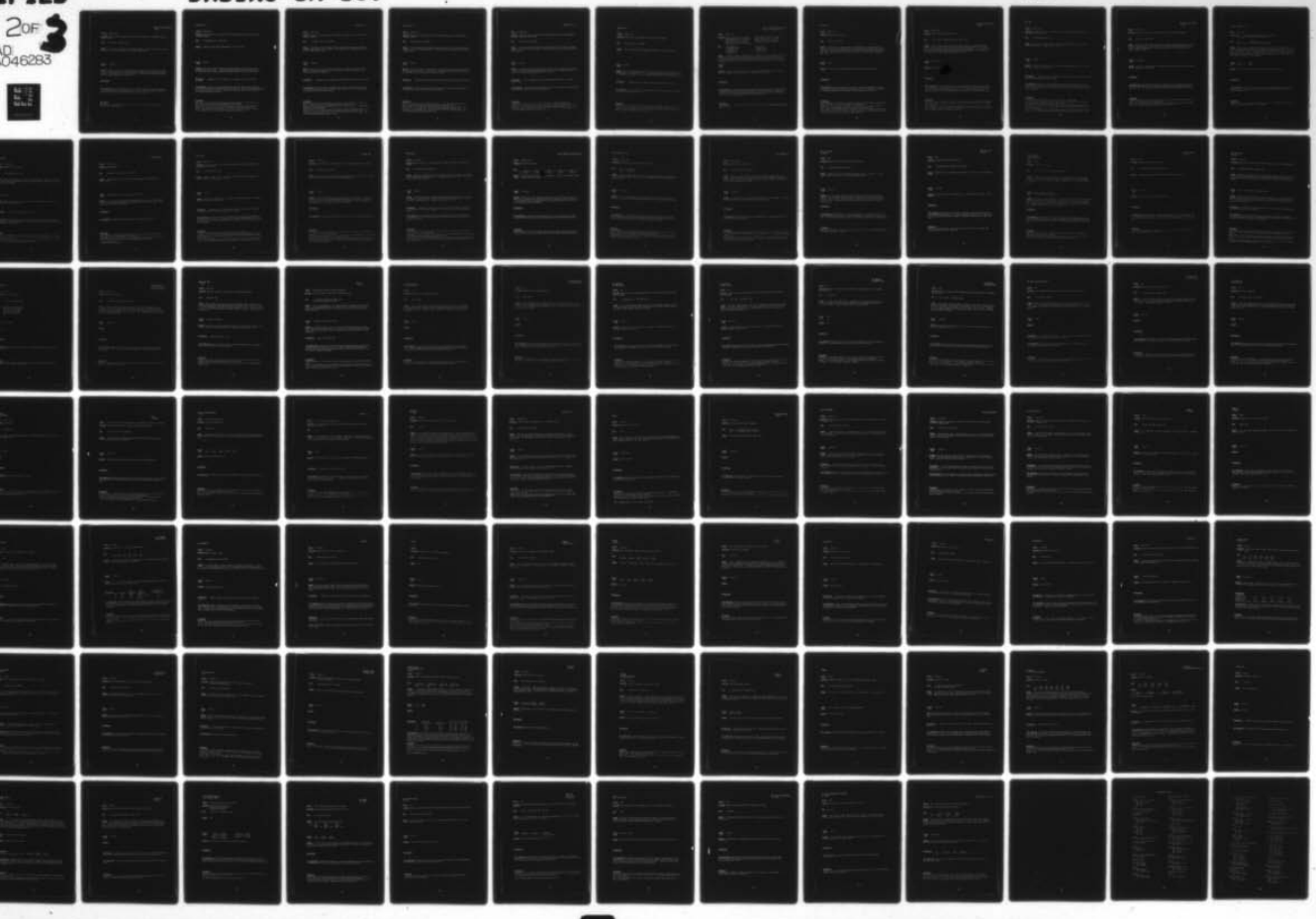
METEOROLOGY: Surface wind varied from 090° at 5 kts to 190° at 8 kts.

TEST OBJECTIVE: A continuation of the 1970 Project Trinidad experiments. Cratering experiments in sandstone-shale to determine DOB curves at various depths and with different types of stemming. One shot was detonated to provide a railroad right-of-way between Long Canyon and Frisco Canyon. Airblast and ground shock measurements were made.

REFERENCES:
Vortman, L.J., *Project MIDDLE COURSE II Airblast and Surface Motion*, December 1962, Sandia Laboratories, SC-44-72-0342.
Sprague, Kenneth E., et al, *MIDDLE COURSE II Cratering Experiments*, July 1973, Army Engineer Waterways Experiment Station, TR E-73-3.

AD-A046 283 GENERAL ELECTRIC CO SANTA BARBARA CALIF DASIAC F/G 19/4
GUIDE TO HIGH EXPLOSIVE FIELD TESTS WITH MILITARY APPLICATIONS --ETC(U)
MAR 77 E L HARNER DNA001-75-C-0023
UNCLASSIFIED DASIAC-SR-159 NL

2 OF 3
AD
A046283



MIDDLE GUST CALIBRATION
9 shots

SERIES: Middle Gust

LOCATION: Crowley County, Colorado, in eastern half of Section 2, Township 21 South, Range 58 West.

DATE: March 1971 to August 1972

CHARGE: TNT. Shots 1,4,5, and 7 were surface tangent. Shot 2 was buried 17 ft, and Shots 3,6,8 and 9 were half-buried. All charges were spherical.

WEIGHT (lb): 1,000 each

GEOLOGY: Shot 1: silty clay over weathered shale, dry. Shots 2 through 9: about 9 ft of alluvial sands, silts, and clays overlying weathered clay shale of the Pierre Formation. Competent shale at a depth of 18 ft. Shallow perched water table caused water to stand in boreholes at a depth of 4 ft.

METEOROLOGY:

TEST OBJECTIVE: Shots 1 through 4 were to obtain data with which to predict stresses, motions and pressures for the Middle Gust Test Series. Shots 5 through 9 emphasized cratering efficiency and scaling techniques in a layered medium.

REFERENCES:

Day, Jerry D., et al, *Middle Gust Calibration Shots, Ground Motion Measurements*, February 1975, AEWES TR N-75-1.

MIDDLE GUST I

SERIES: Middle Gust

LOCATION: Ordway Test Site, 50 miles east of Pueblo, Colorado and 4 miles north of Crowley, Colorado

DATE: 16 September 1971 at 1500 MDT

CHARGE: Half-buried TNT sphere approximately 4.6 ft in radius.

WEIGHT (lb): 40,000

GEOLOGY: Wet site of alluvial cohesive soil approximately 10-ft thick overlying the Cretaceous Pierre shale. A thin, permeable zone of clayey sand within the soil just above the shale yields a parched water table condition very near the surface.

METEOROLOGY: Temperature 13.0°C; humidity 51%; pressure 870.0 mb; wind 080° at 6 kts.

TEST OBJECTIVE: Simulate cratering phenomena and free-field motion resulting from a near-surface nuclear explosion in clay over shale geology. Relate measured ground motion to pretest calculations. Secondary objectives include the study of cloud formation and structural median interaction.

REFERENCES:

Reed, J.W., *Blast Predictions and Microbarograph Measurements, Project Middle Gust Final Report*, August 1973, Sandia Laboratories, SLA-73-0484.
Smith, Paul D., *Investigation of Buried Structures in Middle Gust Test Series, Uninstrumented Structures*, May 1973, Air Force Weapons Laboratory, AFWL-TR-73-57.
Melzer, L.S., *Middle Gust Test Series, Events I, II, III, Test Plan and Prediction Report*, November 1971, Air Force Weapons Laboratory, AFWL-TR-71-147.

SERIES: Middle Gust

LOCATION: Ordway Test Site 50 miles east of Pueblo, Colorado, and 4 miles north of Crowley, Colorado.

DATE: 14 December 1971 at 1215 PM MST

CHARGE: TNT sphere 7.9 ft in radius with the center of the charge at a height of 2 charge radii above the ground surface. The configuration corresponded exactly to that of the Mine Under event.

WEIGHT (lb): 200,000

GEOLOGY: Wet site of 10 ft of alluvial cohesive soil overlying Cretaceous Pierre shale. A perched water condition very near surface is found in permeable zone of clayey sand just above the shale.

METEOROLOGY: Temperature 0.8°C; humidity 22%; pressure 854.1 mb; wind 260° at 2 kts

TEST OBJECTIVE: Simulate cratering phenomena and free-field motion resulting from a near-surface nuclear explosion in clay over shale geology. This test was designed to produce only airblast-induced motions.

REFERENCES:

Melzer, L.S., *Middle Gust Test Series, Events I, II, III, Test Plan and Prediction Report*, November 1971, Air Force Weapons Laboratory, AFWL-TR-71-147.
Freeman, D., et al, *Dynamic Dust Measurements for Middle Gust Event II*, 1 March 1972, TRW Systems Group, DNA-2882F.
Smith, Paul D., *Investigation of Buried Structures in Middle Gust Test Series, Uninstrumented Structures*, May 1973, Air Force Weapons Laboratory, AFWL-TR-73-57.
Jaramillo, E.E., and Pozega, R.E., *Middle Gust Free Field Data Analysis*, April 1974, Air Force Weapons Laboratory, AFWL-TR-73-251.

MIDDLE GUST III

SERIES: Middle Gust

LOCATION: Ordway Test Site, 50 miles east of Pueblo, Colorado, and 4 miles north of Crowley, Colorado

DATE: 13 April 1972 at 1115 MST

CHARGE: 32.6-lb blocks of TNT stacked to form a sphere 7.9 ft in radius and situated tangent to and above the ground surface, centered one charge radius above the ground surface plane.

WEIGHT (lb): 200,000

GEOLOGY: Wet site of 10 ft alluvial cohesive soil approximately 10 ft thick overlying the Cretaceous Pierre shale. A perched water condition very near surface is found in the permeable zone of clayey sand just above the shale.

METEOROLOGY: Temperature 22.6°C; humidity 48%; pressure 848.5 mb; wind 230° at 10 kts.

TEST OBJECTIVE: Produce and measure direct-induced and air-induced ground motions in the proportion expected from a nuclear surface burst.

REFERENCES:

Melzer, L.S., *Middle Gust Test Series, Events I, II, III, Test Plan and Prediction Report*, November 1971, Air Force Weapons Laboratory, AFWL-TR-71-147.
Smith, Paul D., *Investigation of Buried Structures in Middle Gust Test Series, Uninstrumented Structures*, May 1973, Air Force Weapons Laboratory, AFWL-TR-73-57.
Jaramillo, E.E. and Pozega, R.E., *Middle Gust Free Field Data Analysis*, April 1974, Air Force Weapons Laboratory, AFWL-TR-73-251.

SERIES: Middle Gust

LOCATION: Ordway Test Site, 50 miles east of Pueblo and 6.5 miles north of Ordway, Colorado. Elevation, 4600 ft MSL.

DATE: 22 June 1972 at 1400 MDT

CHARGE: 32.6-lb blocks of TNT stacked to form a sphere 7.9 ft in radius, situated tangent to and above the ground surface, centered one charge radius above the ground surface plane.

WEIGHT (lb): 200,000

GEOLOGY: Approximately 6 inches of topsoil overlying a silty, alkaline clay 2-1/2 to 3 ft deep, a highly weathered clay/shale from 7 to 15 ft and a slightly weathered grayish clay/shale below approximately 15 ft. Dry site.

METEOROLOGY: 29.9°C temperature, relative humidity 60%; wind 100° at 7 knots; pressure 863.2.

TEST OBJECTIVE: Simulate cratering phenomena and free-field airblast and ground motion resulting from a near-surface nuclear explosion.

REFERENCES:

Pozega, R.E., *Middle Gust IV Free-Field Data Report*, 1 May 1973, EG&G, Inc.
Smith, Paul D., *Investigation of Buried Structures in Middle Gust Test Series, Uninstrumented Structures*, May 1973, Air Force Weapons Laboratory, AFWL-TR-73-57.
Jaramillo, E.E. and Pozega, R.E., *Middle Gust Free Field Data Analysis*, April 1974, Air Force Weapons Laboratory, AFWL-TR-73-251.

MIDDLE GUST V

SERIES: Middle Gust

LOCATION: Ordway Test Site, Colorado (6.5 miles north of Ordway).

DATE: 10 August 1972 at 1100 MDT

CHARGE: 4.6 ft sphere of TNT half-buried to give HOB = 0 at ground level.

WEIGHT (lb): 40,000

GEOLOGY: Dry site of approximately 6 in. of topsoil overlying a silty alkaline clay which extends to a depth of 2.5 to 3 ft; a highly weathered clay/shale from 3 to 7 ft; weathered shale from 7 to 15 ft; slightly weathered grayish clay/shale below 15 ft.

METEOROLOGY: Temperature 25.6°C; humidity 28%; pressure 868.6 mb; no wind.

TEST OBJECTIVE: Simulate cratering phenomena and free-field ground motion resulting from a near-surface nuclear burst.

REFERENCES:

Smith, Paul D., *Investigation of Buried Structures in Middle Gust Test Series, Uninstrumented Structures*, May 1973, Air Force Weapons Laboratory, AFWL-TR-73-57.
Jaramillo, E.E. and Pozega, R.E., *Middle Gust Free Field Data Analysis*, April 1974, Air Force Weapons Laboratory, AFWL-TR-73-251.

CIST (CYLINDRICAL IN SITU TEST)
Shots 1-11 (No number 10)

SERIES: Middle Gust

LOCATION: Middle Gust Wet Site, Colorado
Mixed Company Test Site, Colorado
Minuteman Site D-1, Nebraska
Middle Gust Dry Site, Colorado
Nevada Test Site Area 10, Nevada
Nevada Test Site Area 6, Nevada
Nevada Test Site Area 5, Nevada
Middle Gust Wet Site, Colorado
Minuteman Site N-11, Missouri

DATE:
16 November 1971
28 September 1971
11 February 1972
17 January 1973
22 May 1973
4 June 1973
23 August 1973
7 February 1974
22 April 1974

CHARGE: Vertical cylindrical loading of 24-in. diameter (or 22-in. diameter for CIST 1) borehole with racked 400-grain PETN detonating cord explosive at a density of five lbs per linear foot of hole. Nominal peak cavity pressure was estimated at 6700 lbs per square in. Boreholes were drilled to a depth of 30-ft except CIST 4 at 35 ft and CIST 9 at 40 ft.

WEIGHT: (lb)

GEOLOGY: Tests 1,8,9, and 11 were at wet sites; the remainder were at dry locations. At various depths, soils were silty clay, sandy clay, or clay shale.

METEOROLOGY:

TEST OBJECTIVE: Eliminate shortcomings in material sampling/laboratory testing approach to material properties definition by conducting a feasibility study to determine the adaptability of the loading/measurement technique to sites of interest for Middle Gust tests. Free-field ground motions and stresses were measured.

REFERENCES:
Davis, Stephen E., *Middle Gust CIST Events Data*, June 1974, Air Force Weapons Laboratory, AFWL-TR-74-137.

MINE DUST HE

SERIES: Mighty Mite

LOCATION: Nevada Test Site, Area 16

DATE: 10 May 1972 at 0500

CHARGE: The center of a tamped charge of nitromethane in an aluminum sphere was located at a depth of 14 ft below the 45 ft drift mined off the right rib of U16a.05 tunnel and 40 ft horizontally from the rib of 16a.05. The drift was filled with grout after installation of the charge. The drift's invert was at an elevation of 5411.3 ft.

WEIGHT (lb): 1,000

GEOLOGY: A relatively dry and compactible zeolitized tuffaceous formation.

METEOROLOGY:

TEST OBJECTIVE: Measure ground shock and seismic waves from underground explosions and develop stemming and containment information. An added experiment was related to developing hardened cables and gages in the gigapascual stress range.

REFERENCES:

Grote, Benjamin, *Mighty Mite Series, Mine Dust Event, Stemming Mechanics Study Series; Stemming Mechanics Study Three*, 7 August 1975, POR 6666.

Riney, T.D., et al, *Constitutive Models and Computer Techniques for Ground Motion Predictions*, 30 March 1973, Systems Science and Software, DNA 3180F.

Adams, James W. and McLaughlin, R.H., *Comparison of Seismic Measurements Taken in the Diamond Dust, Diamond Mine, and Mine Dust HE Series of Events*, February 1973, Environmental Research Institute of Michigan, AFOSR-TR-74-0143.

pre-MINE DUST, PHASE II
3 shots

SERIES: Mighty Mite

LOCATION: Nevada Test Site, Tunnel U12e.06

DATE: 27 July 1973; 7 September 1973; 24 October 1973

CHARGE: TNT in 1000-lb spheres 32.25-in. diameter with 10-in. diameter pentolite booster charge at center were placed at the end of 60-ft long drifts. PMD-1 and PMD-3 were in underground cavities with different quenching media. The cavities in the first and third tests were approximately 11.4 ft in diameter. The access drifts in all three tests were stemmed with rock-matching grout.

WEIGHT (lb): 1,000 each

GEOLOGY: Nevada tuff

METEOROLOGY:

TEST OBJECTIVE: Investigate the physics of energy absorbing techniques for quenching nuclear explosions in an underground cavity. Perform ground coupling experiments to study the effects of carbon impact on cavity walls. Study seismic decoupling. Investigate methods of scaling experimental data from HE tests to larger energy yields.

REFERENCES:

Mighty Mite Series, Pre-Mine Dust Event, Test Execution Report, 6 March 1974, POR 6820.
Mighty Mite Series, Pre-Mine Dust Event, Technical Directors Summary Report, 17 March 1974, POR 6822.
Tanis, Frederick J. and Jurdy, Donna J., *Mighty Mite Series, Pre-Mine Dust Events, Summary of Seismic Measurements Taken in the Pre-Mine Dust Events*, 23 July 1974, Environmental Research Institute of Michigan, POR 6824.

MINE ORE

SERIES: Mine Shaft

LOCATION: 8 miles NW of Cedar City, Utah. On the slope of Three Peaks Mountain at approximately 5000 ft MSL.

DATE: 13 November 1968 at 1200

CHARGE: Stack of TNT blocks with the bottom of the charge 1/10th charge radius below ground surface. Charge radius: 7.9 ft.

WEIGHT (lb): 200,000

GEOLOGY: Laccolith, exceeding 200 ft in thickness (considered locally to be quartz monzonite; classified as tonalite).

METEOROLOGY: Temperature 38.5°F; barometric pressure 808 mb; relative humidity 50%; and wind direction/velocity 10°/13.8 mph.

TEST OBJECTIVE: Study the cratering (including ejecta) and ground shock effects of explosions near the surface of competent, massive bodies of homogeneous rock. Secondarily, to study airblast, dust cloud physics, and response of structures and structural components.

REFERENCES:

Operation Mine Shaft Events Mine Under and Mine Ore, 15 June 1968.
Eleventh Meeting of Panel N-2 (Shock Blast & Thermal), April 21st to 24th, 1969, Atomic Weapons Research EStablishment, August 1969.
Joachim, C.E., *Mine Shaft Series, Event Mine Under and Mine Ore; Subtask SS 222, Ground Motion and Stress Measurements*, January 1972, Army Engineer Waterways Experiment Station, N-72-1.
Meyer, J.W. and Rooke, A.D., Jr., *Mine Shaft Series, Events Mine Under and Mine Ore, Ejecta Studies*, September 1969, Army Engineer Waterways Experiment Station, N-69-2.

MINE SHAFT CALIBRATION
10 shots

SERIES: Mine Shaft

LOCATION: 8 miles NW of Cedar City, Utah on the slope of Three Peaks Mountain

DATE: 21 May to 31 May 1968

CHARGE: Spherically stacked TNT, with a 10-in. diameter pentolite booster cast in the center of the main charge. Charge positions included: bottom of charge below rock surface; bottom of charge above rock surface; and bottom of charge resting on rock surface (surface tangent).

WEIGHT (lb): 1,000 each

GEOLOGY: Granite. Iron-rich quartz monzonite laccolith, with tonalite rock exceeding 200 ft in thickness. Semi-desert.

METEOROLOGY:

TEST OBJECTIVE: Investigate the influence of small changes in the burst position on cratering characteristics for an HE charge detonated in a near-surface geometry in hard rock. Also to evaluate techniques for the large-scale MINE SHAFT test program.

REFERENCES:
Operation Mine Shaft, Events Mine Under and Mine Ore, Preliminary Technical, Administrative and Operational Plan, 15 June 1968.
Davis, L.K., *Mine Shaft Series, Subtask N123, Calibration Cratering Series*, February 1970, Army Engineer Waterways Experiment Station, TR N-70-4.

pre-MINE THROW I, II, III

SERIES: Mine Throw

LOCATION: PMT I: Naval Weapons Center, China Lake, California
PMT II and III: Nevada Test Site, Area 18.

DATE: PMT I: 5 February 1971
PMT II & III: 20 April and 16 September 1971

CHARGE: Shaped charges of ANFO, one-third the size of the Mine Throw I charge, in polyethylene bags each holding ten-lbs of explosive and measuring about 12 x 12 x 3 inches when filled. Five-lb pentolite boosters were almost equally spaced along the inner surface of the charge. The bagged ANFO was placed in an excavated cavity with unbagged ANFO filling the spaces between bags and around boosters. PMT I and II were soil tamped; PMT III was without tamping.

WEIGHT (lb): PMT I & II: 12,000
PMT II: 9,000

GEOLOGY: NTS 18: Silty or sandy residual soil overlying a basalt cap.

METEOROLOGY:

TEST OBJECTIVE: Develop and verify a technique to use shaped HE charges (one-third scale) to simulate the cratering and directly-induced ground motion produced by a nuclear surface burst.

REFERENCES:
McKay, M., et al, *Development and Preliminary Tests of a Cratering and Ground Motion Simulation Technique*, February 1974, DNA 3262F.

pre-MINE THROW IV
(Cal 1 and Cal 2)
(Phase 1: 2 events
Phase 2: 7 events)

SERIES: Mine Throw

LOCATION: Nevada Test Site, Area 6, Yucca Lake

DATE: Cal 1 and Cal 2: 1 June 1973
Phase 1: 1 June 1973
Phase 2: 7 events from 12 August through 4 December 1973
1 event each on 7 August and 12 December 1974

CHARGE: Cal 1 and 2: TNT, tangent above ground. Phase 1 and Phase 2 Events 2, 5 and 7: TNT around a 32.5-lb pentolite booster. Phase 2 Events 1,3,4 and 6: nitromethane with a booster of 3/4-lbs of C4 with an RPI detonator. Phase 1: Spherical, detonated 500 ft apart with no instrumentation. Phase 2 Events 1 and 2: surface tangent in chopped fiberglass spherical container. Phase 2, Events 5 and 7: half-buried sphere. Phase 2, Event 6: surface tangent in spherical cloth-woven fiberglass container.

WEIGHT (lb): Cal 1 and 2: 1,000
Events 1,2,4,5: 1,000
Event 3: 14,320
Event 6: 203,500
Event 7: 256

GEOLOGY: Dry playa lake bed consisting of slightly cemented, thin beds of silt and clay. Vegetation-free, nearly level, unconsolidated alluvial surface.

METEOROLOGY:

TEST OBJECTIVE: Phase 1: Precalibration event for Phase 2 to provide physical crater data to strengthen Phase 2 predictions. Phase 2: Measure ground motion, crater volume, and airblast; secondarily, blast loading on an in-flight helicopter, study of nitromethane, fluid slosh experiments, ejecta studies, splice cases, MX trench concept design and measurements, airblast envisioned flow measurements, and dust cloud sampling.

REFERENCES:
Perry, G.L.E., *Pre-Mine Throw IV Test Execution Report*, 7 January 1975, WT-6826.

MINE THROW I

SERIES: Mine Throw

LOCATION: Nevada Test Site, Area 18

DATE: 15 December 1971 at 1230

CHARGE: Ammonium nitrate/fuel oil (ANFO) mixture in bags and stacked in an ellipsoidal shape, with an ellipsoidal cavity in its upper center. General configuration is below surface tangent.

WEIGHT (lb): 236,000

GEOLOGY: Alluvial fan, with soil of dry, gravelly sand containing numerous cobbles and exhibiting some cementation.

METEOROLOGY: Clear and cold; wind NNW at 20 mph.

TEST OBJECTIVE: Duplicate with a chemical high explosive the cratering and ground shock phenomena of Johnie Boy (nuclear). Develop a mathematical model for the detonation properties of diluted ANFO.

REFERENCES:

Barnes, B.L. and Conwary, J.A., *Event Mine Throw I: Cratering Effects of a Multiton Near-Surface Detonation in Desert Alluvium*, May 1973, Army Engineer Waterways Experiment Station, TR-N-73-3.

Stubbs, T.F., et al, *Mine Throw 1-A Cratering and Ground Motion Simulation Technique*, July 1974, Physics International Company, DNA 3665F.

MINE THROW II*

SERIES: Mine Throw

LOCATION: Eniwetok Atoll

DATE: Planned for February 1972 - June 1973

CHARGE: Recommendation was that diluted ANFO be packaged in waterproof polyethylene bags.

WEIGHT (lb): 400,000 (may be in error as much as 50 percent)

GEOLOGY: Coral sand with some gravel with underlying layer of 2 to 4 ft of beach rock, with a 30-ft thick underlayer of unconsolidated coral sand and gravel. Below this, at a 40-ft depth, is reef rock.

METEOROLOGY:

TEST OBJECTIVE: Planned as an HE simulation of the Cactus nuclear event.

REFERENCES:

McKay, M.W., *Development of Preliminary Design Data for the Mine Throw II Event*, March 1963, Physics International Co., DNA 30372.
Buckingham, A.C., et al, *Calculation of Cactus Ground Motion and Design of the Mine Throw II Charge*, August 1973, Physics International Co., DNA 3141F.

*Documentation in progress.

MINE UNDER

SERIES: Mine Shaft

LOCATION: 8 miles NW of Cedar City, Utah. On the slope of Three Peaks Mountain at approximately 5000 ft MSL

DATE: 22 October 1968 at 1600

CHARGE: Spherical stack of 32.6 6-lb blocks of TNT detonated at 2 charge radii above the surface. Charge radius: 7.9 ft.

WEIGHT (lb): 200,000

GEOLOGY: Laccolith, exceeding 200 ft in thickness (considered locally to be quartz monzonite; classified as tonalite).

METEOROLOGY: Temperature 65.4°F; barometric pressure 820 mb; relative humidity 18 percent; wind direction 300°; wind velocity 2.3 mph.

TEST OBJECTIVE: Study the cratering (including ejecta) and ground shock effects of explosions near the surface of competent, massive bodies of homogeneous rock. Secondarily, to study airblast, dust cloud physics, and response of structures and structural components.

REFERENCES:

Operation Mine Shaft, Events Mine Under and Mine Ore, 15 June 1968.
Joachim, C.E., *Mine Shaft Series, Events Mine Under and Mine Ore; Subtask SS 222, Ground Motion and Stress Measurements*, January 1972, Army Engineer Waterways Experiment Station, N-72-1.
Meyer, J.W. and Rooke, A.D., Jr., *Mine Shaft Series, Events Mine Under and Mine Ore Ejecta Studies*, September 1969, Army Engineer Waterways Experiment Station, N-69-2.

MINERAL LODE

SERIES: Mine Shaft

LOCATION: Three Peaks area, approximately 10 miles northwest of Cedar City, Utah.

DATE: 5 September 1969 at 1200

CHARGE: Chemical slurry poured into a 9-ft diameter cavity, which was then sealed. The center of the cavity was 100 ft below ground surface.

WEIGHT (lb): 32,000

GEOLOGY: Semi-desert environment with juniper trees, sage and cactus. The Three Peaks area is an iron-rich quartz mongonite intrusion, 3 to 5 miles in diameter. Characterized by scattered narrow troughs and depressions filled with sandy silt and weathered rock. Surface relief: ~4 ft, GZ 5750 ft.

METEOROLOGY:

TEST OBJECTIVE: Study ground shock and motions from a fully contained HE detonation.

REFERENCES:

Mine Shaft Series, Events Mineral Lode and Mineral Rock, Technical, Administrative, and Operational Plan, 15 July 1969.

Calhoun, D.C., *Rock Properties Test for Project Mine Shaft*, October 1970, Eric H. Wang Civil Engineering Research Facility, AFWL-TR-70-24.

Murrell, D.W. and Carleton, H.D., *Operation Mine Shaft, Ground Shock from Underground and Surface Explosions in Granite*, April 1973, Army Engineer Waterways Experiment Station, MS-2159 and MS-2160.

MINERAL ROCK

SERIES: Mine Shaft

LOCATION: Three Peaks area, 8 miles northwest of Cedar City, Utah, GZ elevation is 5900 ft.

DATE: 8 October 1969 at 1200 MDT

CHARGE: Spherical configuration of 32.6 lb blocks of TNT. The center of the charge was 0.9 charge radii above ground zero. The charge diameter was ∿18 ft. The charge was buried 1/10 charge radius.

WEIGHT (lb): 200,000

GEOLOGY: Three Peaks areas is an iron-rich quartz monzonite intrusion 3 to 5 miles in diameter. Characterized by scattered narrow troughs and depressions filled with sandy silt and weathered rock. Maximum surface relief: ∿4 ft.

METEOROLOGY: Atmospheric pressure, 816.5 mb; visibility, 15 miles; temperature, 20°C; dew point, 31°C; relative humidity, 28 %; wind direction, 190°; wind speed, 14 kts.

TEST OBJECTIVE: Study cratering ejecta and ground shock from an HE detonation on a rock surface. Also to study the response of selected structures and structural components to air blast.

REFERENCES:

Mine Shaft Series, Events Mineral Lode and Mineral Rock, Technical, Administrative, and Operational Plan, 15 July 1969.
Calhoun, D.E., *Rock Properties Test for Project Mine Shaft*, October 1970, Eric H. Wang Civil Engineering Research Facility, AFWL-TR-70-24.
Murrell, D.W., *Operation Mine Shaft, Mineral Rock Event, Far-out Ground Motions from a 100-ton Detonation over Granite*, April 1972, Army Engineer Waterways Experiment Station, TR N-72-6.

SERIES: Middle North

LOCATION: Glade Park, Colorado

DATE:

	1	2	3	4	5
	15 June 1972	22 June 19[illegible]	12 June 1972	19 June 1972	24 June 1972
at	1300	1100	1100	1100	1045

CHARGE: Cast spheres of TNT with pe[illegible]ite booster. Events 1,3, and 5 were surface tangent. Events 2 and 4 were half-bu[illegible]ed.

WEIGHT (lb): 1,000 each

GEOLOGY: *Sandy-clayey-silt* overburden overlying 70 ft of the Kayenta formation of Triassic age. Events 1 and 2 were on the alluvial overburden. Events 3 and 4 were on the unweathered Kayenta sandstone which was exposed by excavation. Event 5 was on reconstituted alluvial overburden.

METEOROLOGY:

TEST OBJECTIVE: Determine cratering response of soil over sandstone geology and to provide additional data on the effects of geology on crater and debris formation.

REFERENCES:

Pinker, Robert W., *Middle North Series, Mixed Company Event, Small High-Explosive Cratering Calibration Tests*, 15 March 1976, Air Force Weapons Laboratory, POR 6748.

MIXED COMPANY I AND II

SERIES: Middle North

LOCATION: Grand Junction, Colorado (Glade Park area)

DATE: MC I: 1 June 1972
MC II: 13 July 1972

CHARGE: Spherical charges built of 32.6-lb cast TNT blocks. MC I was half buried. MC II rested on the surface with the lower half supported with high-strength polyurethane blocks.

WEIGHT (lb): 40,000 each

GEOLOGY: 5.5 ft of sand overburden with a layer of friable or weak sandstone to a depth of 12 ft, where the competent sandstone started. No significant water content.

METEOROLOGY:

TEST OBJECTIVE: To confirm ground motion predictions for MC III and to rate gages. Also to correlate the crater size and ejecta distribution from previous explosions with the same charge configuration in different soil and rock media.

REFERENCES:

Ullrich, Gilbert W., *The Mechanics of Central Peak Formation in Shock Wave Cratering Events*, May 1976, Air Force Weapons Laboratory, AFWL-TR-75-88.
Ingram, James K., *Middle North Series, Mixed Company Event, Ground Shock from a 500-Ton High-Explosive Detonation on Soil over Sandstone*, 7 August 1975, Army Engineer Waterways Experiment Station, POR 6613.

SERIES: Middle North

LOCATION: Grand Junction, Colorado

DATE: 13 November 1972 at 1140 MST

CHARGE: Spherical charges built of 32.6-lb cast TNT blocks supported on polyurethane blocks resting on four layers of 3/4 in. plywood; tangent to and above the ground surface. Initiation of charge detonation was at the center of the sphere with a 422-lb spherical tetryl charge.

WEIGHT (lb): 1,000,000

GEOLOGY: An overburden of partially cemented, sandy soil over sandstone. The interface between the rock and soil overburden is not distinct.

METEOROLOGY:

TEST OBJECTIVE: Provide data on free-field ground motions, structure-media interaction, and cratering and debris.

REFERENCES:

Pahl, Hermann and Plamondon, Maynard A., *Experimental Investigations of Pressures on Aboveground Structures, Event Mixed Company*, June 1975, Air Force Weapons Laboratory, AFWL-TR-75-74.

Ingram, James K., *Middle North Series, Mixed Company Event, Ground Shock from a 500-Ton High-Explosive Detonation on Soil over Sandstone*, 7 August 1975, Army Engineer Waterways Experiment Station, POR 6613.

MOLE 100 SERIES
12 shots

SERIES: Mole

LOCATION: Dugway Proving Ground, White Sage Flats, Utah

DATE: 28 June through 26 August 1952

CHARGE: Spherical TNT, with 1-lb pentolite booster cast in the center. Charge depth varied from -6.35 ft to +6.35 ft from ground surface.

WEIGHT (lb): 256 each

GEOLOGY: Dry clay made up of great depths of lake sediment (fine unconsolidated material) with very thin sand lenses. Below a depth of 20 ft occurred sand beds from one to 20 ft thick. Also present was a white marl layer and thin discontinuous beds of clay. Ground water was negligible and the water table was a depth of 300 ft or more.

METEOROLOGY:

TEST OBJECTIVE: Measurement of free field earth effects from underground and near surface aboveground explosions. Included measurement of earth stress, strain, pressure, acceleration and airblast pressure. Determined displacements and crater profiles.

REFERENCES:
Sachs, D.C. and Swift, L.M., *Small Explosion Tests, Project Mole*, December 1955, Stanford Research Institute, AFSWP-291.

MOLE 200 SERIES
13 shots

SERIES: Mole

LOCATION: Nevada Proving Ground, Yucca Flat

DATE: 11 September 1952 through 22 October 1952

CHARGE: Spherical TNT. Charge depth varied from -6.35 ft to +6.35 ft from ground surface.

WEIGHT (lb): 256 each

GEOLOGY: Alluvial fill in a basin range valley. Extremely dry. Basically a sand-gravel mix.

METEOROLOGY:

TEST OBJECTIVE: Measurement of free field earth effects from underground and near surface aboveground explosions. Included measurement of earth stress, strain, pressure, acceleration and airblast pressure. Determined displacements and crater profiles.

REFERENCES:
Sachs, D.C. and Swift, L.M. *Small Explosion Tests, Project Mole*, December 1955, Stanford Research Institute, AFSWP-291.

MOLE 300 SERIES
11 wet sand shots
3 moist clay shots

SERIES: Mole

LOCATION: Camp Cooke, California

DATE: 15 September 1953 through 24 October 1953

CHARGE: Spherical TNT charges fired at levels ranging from 4.7 ft below ground surface to 0.8 ft above ground for 13 shots. 50-lb and 10-lb sticks of seismic 60 percent high velocity dynamite was used for Round 305A at 3.17 ft above ground surface.

WEIGHT (lb): 256 TNT each except for
290 lb dynamite for Round 305A

GEOLOGY: Wet site: ground surface was .3 ft above the water level. Soil consisted of silty sand mixed with organic matter for the first two ft with saturated sand underlying the area. At a depth of 20 ft under sand is Monterey shale. Moist clay site: Ground surface was 5 ft above water table level. Surface soil was hard clay silt underlain by moist sandy clay to a depth of 22 ft.

METEOROLOGY:

TEST OBJECTIVE: Measurement of free field earth effects from underground and near surface aboveground explosions. Included measurement of earth stress, strain, pressure, acceleration and airblast pressure. Determined displacements and crater profiles.

REFERENCES:

Sachs, D.C. and Swift, L.M., *Small Explosion Tests, Project Mole*, December 1955, Stanford Research Institute, AFSWP-291.
Swift, L.M. and Sachs, D.C., *Small Explosion Tests, Phase II of Project Mole, 2nd Interim Report*, May 1954, Stanford Research Institute, AFSWP-289.

MOLE 400 SERIES
6 shots

SERIES: Mole

LOCATION: Nevada Proving Ground, Yucca Flat

DATE: 23 October 1954 through 4 November 1954

CHARGE: Spherical TNT. Charge depth varied from 0.83 ft to 6.35 ft.

WEIGHT (lb): 256 each

GEOLOGY: *Extremely dry alluvial sand-gravel mix.*

METEOROLOGY:

TEST OBJECTIVE: Measurement of free field earth effects from underground and near surface aboveground explosions. Included measurement of earth stress, strain, pressure, acceleration and airblast pressure. Determined displacements and crater profiles.

REFERENCES:
Sachs, D.C. and Swift, L.M., *Small Explosion Tests, Project Mole*, December 1955, Stanford Research Institute, AFSWP-291.

MONO LAKE-1965
10 shots

SERIES: Mono Lake

LOCATION: South shore of Mono Lake, California (east of the Sierra Nevada Mountains)

DATE: 13 August through 8 September 1965

CHARGE: Spherical TNT charges of 5.67 ft diameter detonated at depths ranging from 0.0 to 51.5 ft from the water surface. Charge weights varied from one 900-lb calibration shot to the nine shots of 9,163 to 9,250 lbs including an 84-lb pentolite booster.

WEIGHT (lb): 9,163 - 9,250; 900 for calibration shot

GEOLOGY: Mono Lake Basin is of fairly recent volcanic activity. North, south, and east of the lake is largely of volcanic origin. The beach on the lakeshore consists mostly of pumice sand. Altitude of lake is above 6390 ft MSL. Water depth 1 mile from shore is over 100 ft.

METEOROLOGY: Temperatures varied from 65°F to 82°F; winds usually calm; barometric pressure averaged 29.77 in. of mercury.

TEST OBJECTIVE: Acquire and analyze data on generation, propagation, and runup of explosion generated water waves, and validate prediction techniques and provide overall assessment of explosion generated wave phenomena.

REFERENCES:

Rooke, A.D., Jr., et al, *Mono Lake Explosion Test Series, 1965: Results of the Wave Runup Experiments*, December 1967, Army Engineer Waterways Experiment Station, AD 826156.

Whalin, R.W., et al, *Mono Lake Explosion Test Series, 1965: Analysis of Surface Wave and Wave Runup Data*, August 1970, Army Engineer Waterways Experiment Station, TR-N-70-12.

Wallace, N.R. and Baird, C.W., *Explosion Generated Waves, 1965 Mono Lake Test Series*, 10 December 1968, Oceanographic Services, Inc., OSI 192-2.

MONO LAKE-1966
2 shots

SERIES: Mono Lake - 1966

LOCATION: Mono Lake, California

DATE: 1966, late summer

CHARGE: TNT at depth of burst of 13.10 ft for shot 1, 5840 ft from shore, placed on bottom; and 10.0 ft for shot 2, 3140 ft from shore, placed in a small crater in the lake bottom with center of sphere below bottom level.

WEIGHT (lb): 9,200 each

GEOLOGY: Mono Lake Basin is of fairly recent volcanic activity. North, south, and east of the lake is largely of volcanic origin. The beach on the lakeshore consists mostly of pumice sand. Altitude of lake is above 6390 ft MSL. Water depth 1 mile from shore is over 100 ft.

METEOROLOGY:

TEST OBJECTIVE: Acquire and analyze data on generation, propagation and runup of explosion generated water waves, and validate prediction techniques and provide overall assessment of explosion generated wave phenomena.

REFERENCES:

Explosion Generated Shallow Water Waves, Mono Lake Tests, April 1967, Oceanographic Services, Inc.

Kriebel, A.R. and Kennedy, M.P., *Analysis of Surfaces Waves from Explosions in Shallow Water and Bottom Erosion Tests*, October 1970, URS Research Co., URS 679-7.

MONO LAKE-1966
4 shots

SERIES: Mono Lake

LOCATION: Mono Lake, California

DATE: 3,12,19 and 21 August 1966

CHARGE: Spherical cast TNT charges.
600 lb at 0.42 ft DOB;
9250 lb at 23.0 ft DOB;
9252 lb at 600 ft DOB;
9233 lb at 5.2 ft DOB.

WEIGHT (lb): 600 to 9,252

GEOLOGY:

METEOROLOGY:

TEST OBJECTIVE: Measure water surface waves from underwater detonation at varied depths of burst.

REFERENCES:
Oceanographic Services, Inc., *Final Report, Water Surface Wave Measurements Experiment-Mono Lake*, January 1967, NVO-266-1.

MONO LAKE-1966
12 shots (3 for each
of 4 explosives)

SERIES: Mono Lake

LOCATION: Mono Lake, California

DATE: 2 September 1966 to 9 September 1966

CHARGE: ANOIL; Slurry; Liquid nitromethane; TNT. The TNT cast spherical charge was placed in a nylon lifting sling. All other charges were loaded in 55-gallon fuel drums placed on a plywood base with 1/4 in. steel cables providing lifting slings. The drums were banded together with steel straps. All charges were fired at a depth of 70 ft in 124 ft of water.

WEIGHT (lb): 2,000 each

GEOLOGY:

METEOROLOGY:

TEST OBJECTIVE: Compare different types of chemical explosives for their efficiency in generating seismic signals when generated under water. Examine hydroacoustic shock values.

REFERENCES:
Hecht, R., et al, *Comparison of Hydroacoustic Shock Waves from Four Different Explosives*, March 1967, Underwater Systems, Inc.

MONO LAKE-1969
5 shots

SERIES: Mono Lake

LOCATION: Mono Lake, California (East of the Sierra Nevada Mountains)

DATE: Summer of 1969

CHARGE: HBX-1 charges used for 4 shots were cast spheres with a radius of 3 ft. One lithanol charge was loose powder packed in a spherical steel case with a radius of 3.5 ft. HBX weight: 10,000 lb. Lithanol Weight: 11,516 lb. Tests were fired in 100 ft of water, one-half mile from shore, with depth of burst ranging from 5.2 to 10.7 ft.

WEIGHT (lb): 10,000 to 11,500 each

GEOLOGY: Large salt lake at an altitude of 6400 ft. Fairly regular shoreline over limited distances (several thousand feet); beach slopes from 1/20 to 1/50.

METEOROLOGY: Ambient pressure 11.5 psi.

TEST OBJECTIVE: Measure air blast from large shallow underwater bursts, underwater shock waves, and bulk cavitation phenomena.

REFERENCES:

Gaspin, J.B., *Underwater Pressure Measurements at Mono Lake, California-1969*, 30 September 1970, Naval Ordnance Laboratory, NOLTR 70-187.
Pittman, Joseph, *Airblast from Underwater Explosions; Mono Lake*, 12 November 1970, NOLTR 70-212.

MTCE
23 shots

SERIES: MTCE (Multiple Threat Cratering Experiment)

LOCATION: U.S. Army Yakima Firing Center, Washington, Range 7

DATE: 3 calibration events in January 1965
20 events in June and July 1965

CHARGE: TNT. Two hemispherical, all others spherical; tangent above ground, half-buried, and tangent below ground. Burst depths: 0.0 to +5.5 and -2.2 ft. All charges were constructed of 8-lb 2 x 12 x 6 in. blocks of cast TNT with a density of ∿92 lb/cu ft.

WEIGHT (lb): 3 3,000; 2 16,000; and 18 4,000

GEOLOGY: A weathered surface of columnar jointed, moderately scoriaceous basalt flow. Under 50 ft of basalt flow, i.e., 40 to 50 ft of sediments composed of interbedded tuffaceous sandstone, volcanic ash and brown clay, below which is a second basalt flow.

METEOROLOGY: Semi-arid climatic zone.

TEST OBJECTIVE: Investigate and evaluate cratering, ground shock and related effects resulting from TNT detonations at or near a basalt surface; evaluate methods of stacking TNT charges; study energy coupling modes; investigate the feasibility of the successive cratering technique.

REFERENCES:

O'Brien, Thomas E., et al, *Multiple Threat Cratering Experiment*, April 1967, AFWL-TR-67-8.

Henry, R.W. and Carlson, R.H., *Natural Missile Distributions for High Explosive Craters in Hard Rock*, Volume III, *Multiple Threat Cratering Experiment, June 1970*, Air Force Weapons Laboratory, AFWL-TR-67-8 Vol. III.

NOL CHESAPEAKE BAY
11 shots (PW series)

SERIES: NOL

LOCATION: Chesapeake Bay, Solomons, Maryland

DATE: Fall of 1964

CHARGE: Five lithanol charges: spherical, fully cased in 1/8-in. thick aluminum. Six pentolite charges: spherical, cast; bottom half covered with a case of 1/8-in. thick aluminum used to suspend the charge. DOB varied from 60 to 100 ft in 150 ft of water.

WEIGHT (lb): 300 each

GEOLOGY:

METEOROLOGY:

TEST OBJECTIVE: Develop scaling techniques for steam producing explosives under water. Measure phenomena such as shock wave pressure-time histories, bubble pulses and migration, maximum bubble radius, and above surface effects.

REFERENCES:
Phillips, D.E. and Willey, R.L., *Underwater Explosion Tests of Two Steam Producing Explosives*, 22 March 1967, U.S. Naval Ordnance Laboratory, NOLTR 67-7.

NOL CHESAPEAKE BAY
9 shots (PW series)

SERIES: NOL

LOCATION: Chesapeake Bay, Solomon, Maryland

DATE: Summer 1965

CHARGE: Three pentolite charges, spherical, cast, bottom half covered with a case of 1/8-in. thick aluminum used to suspend the charge. Six H_2O_2/Al charges: cylindrical, walls of 3/16-in. aluminum, top and bottom of 3/4-in. aluminum DOB varied from 60 to 100 ft in 150 ft of water.

WEIGHT (lb): 300 each

GEOLOGY:

METEOROLOGY:

TEST OBJECTIVE: Develop scaling techniques for steam producing explosives under water. Measure phenomena such as shock wave pressure-time histories, bubble pulses and migration, maximum bubble radius, and above surface effects.

REFERENCES:

Phillips, D.E., and Willey, R.L., *Underwater Explosion Tests of Two Steam Producing Explosives*, 22 March 1967, U.S. Naval Ordnance Laboratory, NOLTR 67-7.

NOL DAHLGREN
12 100-lb shots

SERIES: NOL

LOCATION: Dahlgren, Virginia (between Beabors Point and Black Marsh on the Pumpkin Neck Peninsula)

DATE: 22 September 1952 - 18 November 1952

CHARGE: Two 50-lb TNT Mark 14 demolition blocks were strapped together to form a cube about 13-in. long on each side. Placed on river bottom from charge depth of 0 to 5.06 ft. Charge depth is midpoint of charge.

WEIGHT (lb): 100 each

GEOLOGY: Bottom consisted of a firm clay or sand to a water depth of about 5 ft. At greater depths was soft silt.

METEOROLOGY:

TEST OBJECTIVE: Obtain data on the scaling of surface phenomena from shallow underwater explosions. Experimental studies of base surge and water formation.

REFERENCES:

Milligan, M.L. and Young, George A., *The Scaling of Base Surge Phenomena of Shallow Underwater Explosions*, May 1954, U.S. Naval Ordnance Laboratory, AFSWP 484.
Young, G/A., *Crater Formation by Shallow Underwater Explosions at Dahlgren, Virginia*, 1 July 1953, U.S. Naval Ordnance Laboratory, AFSWP-263.

NOL DAHLGREN
20 600-lb shots

SERIES: NOL

LOCATION: Dahlgren Virginia (between Beabors Point and Black March on the Pumpkin Neck Peninsula)

DATE: 27 June 1950 - 18 November 1952

CHARGE: TNT Mark 7 depth charges, 24-7/8 in. in diameter and 27-5/8 in. long. The length of the casing includes rims ∿1 in. high, which sank into the bottom when the charges were placed on end for firing. Fifteen were bottom shots; the center was ∿1.07 ft above the river bottom.

WEIGHT (lb): 600 each

GEOLOGY: Bottom consisted of a firm clay or sand to a water depth of about 5 ft. At greater depths was soft silt.

METEOROLOGY:

TEST OBJECTIVE: Obtain data on the scaling of surface phenomena from shallow underwater explosions. Experimental studies of base surge and crater formation.

REFERENCES:

Milligan, M.L. and Young, George A., *The Scaling of Base Surge Phenomena of Shallow Underwater Explosions*, May 1954, U.S. Naval Ordnance Laboratory, AFSWP 484.
Young, G.A., *Crater Formation by Shallow Underwater Explosions at Dahlgren, Virginia*, 1 July 1953, U.S. Naval Ordnance Laboratory, AFSWP-263.

NOL DAHLGREN
One 3600-lb shot

SERIES: NOL

LOCATION: Dahlgren, Virginia (between Beabors Point and Black Marsh on the Pumpkin Neck Reservoir)

DATE: Fall of 1952

CHARGE: Six Mark 7 TNT depth charges, detonated in the central charge which was encircled horizontally by the others. Detonated at a charge depth of 5.29 ft in a 9.42 water depth. Charge was supported on a wooden platform.

WEIGHT (lb): 3,600

GEOLOGY: Silt

METEOROLOGY:

TEST OBJECTIVE: Obtain data on the scaling surface phenomena from shallow underwater explosions. Experimental studies of base surge and crater formation.

REFERENCES:
Milligan, M.L. and Young, George A., *The Scaling of Base Surge Phenomena of Shallow Underwater Explosions*, May 1954, U.S. Naval Ordnance Laboratory, AFSWP 484.
Young, G.A., *Crater Formation by Shallow Underwater Explosions at Dahlgren, Virginia*, July 1953, U.S. Naval Ordnance Laboratory, AFSWP-263.

NOL DAHLGREN
28 4200-lb shots

SERIES: NOL

LOCATION: Dahlgren, Virginia (between Beabors Point and Black March on the Pumpkin Neck Peninsula)

DATE: 10 July 1950 - 18 November 1952

CHARGE: Seven Mark 7 TNT depth charges, detonated in the central charge which was encircled horizontally by the others. Each charge was 24-7/8 in. in diameter and 27-5/8 in. long, making the charges 3 times as wide as they were high. Eighteen tests were bottom detonations; 10 ranged from a depth of 2.29 to 5.42 ft. Charge depth is midpoint of charge.

WEIGHT (lb): 4,200 each

GEOLOGY: Bottom consisted of a firm clay or sand to a water depth of about 5 ft. At greater depths was soft silt.

METEOROLOGY:

TEST OBJECTIVE: Obtain data on the scaling of surface phenomena from shallow underwater explosions. Experimental studies of base surge and crater formations.

REFERENCES:

Milligan, M.L. and Young, G.A., *The Scaling of Base Surge Phenomena of Shallow Underwater Explosions*, May 1954, U.S. Naval Ordnance Laboratory, AFSWP 484.
Young, G.A., *Crater Formation by Shallow Underwater Explosions at Dahlgren, Virginia*, 1 July 1953, U.S. Naval Ordnance Laboratory, AFSWP-263.

NOL SEVIER BRIDGE RESERVOIR

SERIES: NOL

LOCATION: Sevier Bridge Reservoir, 115 miles south of Salt Lake City, Utah

DATE: 24 November at 1408 MST

CHARGE: Mark 14 TNT demolition blocks weighing 50 lb each and about 6 in. x 13 in. x 13 in. were stacked with tracer material, held in plywood boxes, into a wooden cradle buoyed by steel drums. Water depth 24 ft; charge depth 11.1 ft to center of charge.

WEIGHT (lb): 90,000

GEOLOGY:

METEOROLOGY: Light wind and calm water. Visibility 30 miles; temperature 50.1°F; relative humidity 54%; barometric pressure 25.164 in.

TEST OBJECTIVE: Scale the base surge of a high-explosive in shallow water with Test Baker of Operation Crossroads at Bikini.

REFERENCES:

Young, G.A., *Effects of the Explosion of 45 Tons of TNT Under Water at a Depth Scaled to Test Baker*, U.S. Naval Ordnance Laboratory, AFSWP-485.

NOL STUMP NECK
112 100-lb shots

SERIES: NOL

LOCATION: Stump Neck, Maryland (Potomac River)

DATE: 15 February 1950 - 28 March 1952

CHARGE: Two 50-lb TNT Mark 14 demolition blocks were strapped together to form a cube about 13 in. long on each side. Placed on river bottom from charge depth of 0 to 17.0 ft. Charge depth is midpoint of charge.

WEIGHT (lb): 100 each

GEOLOGY:

METEOROLOGY:

TEST OBJECTIVE: Obtain data on the scaling of surface phenomena from shallow underwater explosions. Experimental studies of base surge and crater formation.

REFERENCES:
Milligan, M.L. and Young, G.A., *Crater Formation by Shallow Underwater Explosions at Dahlgren, Virginia*, 1 July 1953, U.S. Naval Ordnance Laboratory, AFSWP-263.

NOL STUMP NECK
5 600-lb shots

SERIES: NOL

LOCATION: Stump Neck, Maryland

DATE: 15 February 1950 - 13 June 1950

CHARGE: Mark 7 TNT depth charges, 24-7/8 in. in diameter and 25-5/8 in. long. The length of the casing includes rims ∿1-in. high, which sank into the bottom when the charges were placed on end for firing. Four were bottom detonations; one at charge depth of 4.58 ft.

WEIGHT (lb): 600 each

GEOLOGY:

METEOROLOGY:

TEST OBJECTIVE: Obtain data on the scaling of surface phenomena from shallow underwater explosions. Experimental studies of base surge and crater formation.

REFERENCES:

Milligan, M.L. and Young, George A., *The Scaling of Base Surge Phenomena of Shallow Underwater Explosions*, 1 May 1954, U.S. Naval Ordnance Laboratory, AFSWP 484.
Young, G.A., *Crater Formation by Shallow Underwater Explosions at Dahlgren, Virginia*, 1 July 1953, U.S. Naval Ordnance Laboratory, AFSWP-263.

NOL STUMP NECK
5 100-lb shots

SERIES: NOL

LOCATION: Stump Neck, Maryland

DATE: 2 March 1951 - 27 August 1951

CHARGE: Twenty-lb packages of blasting gelatin were combined to form 100-lb charges. Charge depth from 0 to 1.25 ft measured from bottom of charge in water depths from 2.33 to 2.75 ft.

WEIGHT (lb): 100 each

GEOLOGY:

METEOROLOGY:

TEST OBJECTIVE: Obtain data on the scaling of surface phenomena from shallow underwater explosions. Experimental studies of base surge and crater formation.

REFERENCES:

Milligan, M.L. and Young, George A., *The Scaling of Base Surge Phenomena of Shallow Underwater Explosions*, May 1954, U.S. Naval Ordnance Laboratory, AFSWP 484.
Young, G.A., *Crater Formation by Shallow Underwater Explosions at Dahlgren, Virginia*, 1 July 1953, U.S. Naval Ordnance Laboratory, AFSWP-263.

NORTH WIND
(USCG Icebreaker)

SERIES: Arctic Ocean

LOCATION: Arctic Ocean

DATE: September 1965

CHARGE: Charge (not described) dropped by icebreaker Northwest into 1150 ft water. Detonation depth 200 ft.

WEIGHT (lb): 1,350

GEOLOGY:

METEOROLOGY:

TEST OBJECTIVE: Analyze hydroacoustic signals.

REFERENCES:

Young, D.F., et al, *Spectral Analysis of Hydroacoustic Signals Generated by the Chase IV, Chase VII, NOL-VELA, and Arctic Explosions, Technical Progress Report No. 21*, 30 July 1968, Underwater Systems, Inc.

PACE
12 shots

SERIES: PACE (Pacific Cratering Experiments, including Micro Atoll and Coral Sands)

LOCATION: Eniwetok Proving Ground, Island of Aomon, Marshall Islands

DATE: 12 June 1972 to date (June 1976)

CHARGE: Cast TNT spheres. HOBs ranged from two charge radii above the surface to one charge radius below the surface.

WEIGHT (lb): 1,000 each

GEOLOGY: Unconsolidated coral sand, totally saturated, nearly homogeneous.

METEOROLOGY:

TEST OBJECTIVE: Establish empirical means of relating Pacific nuclear craters to craters in geologies of more strategic interest. Data were to be compared with Middle Gust data.

REFERENCES:

Lamping, Neal E., *A Determination of the Geologic Effects on Nuclear Crater Formation by High Explosive Simulation Techniques*, May 1974, AD 920 550L.
Ferritto, J.M. and J.B. Forrest, *Ground Motions from Pacific Cratering Experiments 1,000-Pound Explosive Shots*, January 1975, NCEL TR 808.
Coral Sands Program Proposal, 6 December 1971, Air Force Weapons Laboratory.

PACIFIC PROVING GROUND HE
5 shots

SERIES: Pacific Proving Ground

LOCATION: Eniwetok, Eugelab Island

DATE: Spring 1952

CHARGE: Combination of R-7-HDA (C-2) and R-7-HCA (Tetrytal), primacord and blasting caps. Beehive shape on the surface which had been excavated down to the high tide level.

WEIGHT:	1	2	3	4	5
(lb)	2,000	10,000	20,000	30,000	40,000

GEOLOGY: Water saturated coral sand

METEOROLOGY:

TEST OBJECTIVE: Establish a soil factor for comparing saturated coral with Nevada soil.

REFERENCES:
Carlson, R.H., *Ejecta Distribution from Cratering Events in Soil and Rock*, February 1965, Air Force Weapons Laboratory, AFWL TR-64-111.
Vaile, R.B., *Operation Castle, Project 3-2, Crater Survey*, June 1954, Stanford Research Institute, WT-920.

PLEX NO. 6

SERIES: PLEX (Playa Ejecta Experiments)

LOCATION: McCormick Ranch Test Site, 7 miles south of Kirtland Air Force Base, Albuquerque, New Mexico

DATE: 1973

CHARGE: Cast TNT sphere 2.67 ft in diameter. DOB 0.41 with charge center above ground level. Detonated in a surface-tangent configuration. Area surrounding ground zero was sprayed with a liquid latex for dust control.

WEIGHT (lb): 1,000

GEOLOGY: Dry lake bed playa with relatively homogeneous subsurface conditions.

METEOROLOGY: Wind velocity 2.78 km/hr or less.

TEST OBJECTIVE: Determine if the cratered mass is primarily ejected, compacted, or lost, owing to dust cloud formation. Compare mass distributions from 8-lb TNT with that from 1,000-lb TNT.

REFERENCES:

Terlecky, P.M., Jr., "Mass Partition in Soil Cratering," *Journal of Geophysical Research*, Vol 78, No. 32, 10 November 1973, pp 7671-7674.
Terlecky, P.M., Jr., *Crater and Mass Data for High Explosive Cratering in Playa*, February 1974, Air Force Weapons Laboratory, AFWL-TR-73-269.

POKEHOLES
27 shots

SERIES: Pokeholes

LOCATION: Peason Ridge Training Area, Fort Polk, Louisiana

DATE: Fall 1973

CHARGE: Twenty-four 500-lb detonations, consisting of 3 each of 8 different explosives (ANFO, TNT, 2 commercial slurries, 4 experimental slurries) plus 3 Hercules pretest slurries. All charges were buried at or near their optimum depth of burst ranging from 10.1 ft to 13.7 ft DOB. ANFO was poured into double thick plastic sleeves to protect it from down-hole moisture; slurry was poured downhole; length-to-diameter ratios were 4:1 or less. Primers were pentolite boosters strung on detonating cord. Stemming was native material removed in drilling the holes.

WEIGHT (lb): 500 each

GEOLOGY: Clay-silt sand overlying interstratified layer of sands, silts, and clays. Water at depths ranging from 3 to 25 ft in the borings. Grass-type vegetation.

METEOROLOGY:

TEST OBJECTIVE: Measure the cratering effectiveness of four experimental slurries as compared with that of other explosives, and demonstrate the relationship between crater size and total energy of the explosive charge and the effect of soil conditions on crater shapes.

REFERENCES:
Pokeholes Cratering Series; Explosive Comparison Tests Conducted at Fort Polk Louisiana, Fall 1973, March 1976, Army Engineer Waterways Experiment Station, WES-MP-N-76-3.

SERIES: Middle North

LOCATION: Suffield (DRES), Watching Hill site. Alberta, Canada

DATE: 9 August 1968 at 1000 MST

CHARGE: TNT block-built sphere tangent to and above the ground surface. Lower half of charge was supported by high-strength styrofoam precut to follow the contour of the charge. The styrofoam and TNT rested on a layer of 4 sheets of 3/4-inch plywood.

WEIGHT (lb): 996,600

GEOLOGY: Five-foot surface layer of silty clay underlain by a 27-ft bed of fine silty sand. A layer of soft gray clay extends from 80 to more than 100-ft. Average water table depth is 24 ft.

METEOROLOGY: Ambient pressure, 13.79 psi; surface temperature, 89.2°; humidity, 36%; sun, bright; wind, 0.9 mph at 320°; 1.8 mph at 150°.

TEST OBJECTIVE: Shock and blast experiment to determine the loading and response of military targets subjected to air blast and ground shock. Both surface and subsurface targets were exposed. Also sought fundamental data on high-pressure airblast and on the dynamics of crater formation and debris throwout.

REFERENCES:

Giglio-Tos, L. and B.A. Pettit, *Middle North Series, Prairie Flat Event, Project Officer's Report, Fundamental Blast Studies,* 1 March 1971, Army Ballistic Research Laboratories, POR-2100.

Dudash, M.J., ed., *Operation Prairie Flat Preliminary Report,* Vols 1-3, January 1969, General Electric Company–TEMPO, DASA 2228, DASIAC SR 79.

ROWBOAT

SERIES: Plowshare

LOCATION: Nevada Test Site, Area 10

DATE: 1961

CHARGE: TNT cast spheres; seven rows of four charges; one row of three charges; two single charges. DOBs were 1.0, 1.25, and 1.5 times the optimum for single-charge crater radius; spacings were 1.0, 1.25, and 1.5 radii.

WEIGHT (lb): 278 each row

GEOLOGY: Desert alluvium

METEOROLOGY:

TEST OBJECTIVE: Extend row-charge cratering experience to depths of burst deeper than optimum with larger charges.

REFERENCES:

Spruill, J.L., *Project Dugout Apparent Crater Studies, Final Report*, 3 August 1965, Army Engineer Nuclear Cratering Group, PNE-601F.

Spruill, J.L. and F.F. Videon, *Studies of the Pre-Buggy II Apparent Craters*, June 1965, Army Engineer Nuclear Cratering Group, PNE-315F.

Note: *Summary Report, Project Rowboat*, UCRL-12118

SAILOR HAT ALPHA
2 shots

SERIES: Sailor Hat

LOCATION: Off San Clemente Island, California

DATE: Shot 1: 12 November 1964 at 1555 PST
Shot 2: 14 November 1964 at 1617 PST

CHARGE: Both shots were of HBX 200 ft under water.

WEIGHT (lb): 40,000 each

GEOLOGY:

METEOROLOGY:

TEST OBJECTIVE: Determine effects of underwater shock and airblast on equipment, in preparation for 1,000,000 lb shots.

REFERENCES:

Anacko, W., *Operation Sailor Hat, Effects of Underwater Shock and Airblast Environment on ASW Equipment*, 3 August 1966, POR-4063.
Finneran, W., *Operation Sailor Hat-Project 9.2, Final Report*, 13 August 1965, DASA 1685.

SAILOR HAT BRAVO

SERIES: Sailor Hat

LOCATION: Kahoolawe Island, Hawaii (20°30'29"N, 156°40'53"W) Eastern Shore, Vicinity of Smuggler Cove

DATE: 6 February 1965 at 1431 HST

CHARGE: 30,674 bare TNT blocks, each measuring 12" x 12" x 4" and weighing 32.98 lbs, were stacked on an octagonal concrete pad on the ground surface to form a hemisphere ~34 ft in diameter.

WEIGHT (lb): 1,000,000

GEOLOGY: Volcanic rock 20 ft above sea level. Surface rock flow is a light gray, slightly vesicular granular andesitic basalt. Underneath is a vesicular dark gray basalt. Clay zones existed in all drill holes.

METEOROLOGY: Scattered cumulus clouds; GZ wind 235° at 8 kts; air temperature 29.4°C; pressure 1008.4 mb; relative humidity 50%; air density 1.152 kg/m^3; visibility 10 miles.

TEST OBJECTIVE: Effects of high-energy airblast loading and underwater shock on surface ships, particularly as to effect on weapon delivery, seaworthiness, and mobility.

REFERENCES:

Armstrong, W.J., *Operation Sailor Hat, Technical Directors Report*, 30 January 1969, Naval Ship Engineering Center, POR-4068.
Preliminary Progress Report, Operation Sailor Hat, Event Bravo, 1 April 1965, Bureau of Ships, D-2935/43.

SERIES: Sailor Hat

LOCATION: Kahoolawe Island, Hawaii (20°30'71"N, 156°40'54.17"W), Eastern Shore. Vicinity of Smuggler Cove.

DATE: 16 April 1965 at 1521 HST

CHARGE: 30,674 bare TNT blocks, each measuring 12" x 12" x 4 " and weighing 32.98 lbs were stacked on an octagonal concrete pad on the ground surface to form a hemisphere ∿34 ft in diameter.

WEIGHT (lb): 1,000,000

GEOLOGY: Volcanic rock 20 ft above sea level. Surface rock flow is light gray, slightly vesicular granular andesitic basalt. Underneath is a vesicular dark gray basalt. Clay zones existed in all drill holes.

METEOROLOGY: Entire island obscured by clouds; wind direction 195° at 6 kts; air temperature 26.7°C; pressure 1008.8 mb; humidity 54%; air density 1.182 kg/m^3; visibility 10 miles.

TEST OBJECTIVE: Effects of high-energy airblast loading and underwater shock on surface ships, particularly as to effects on weapon delivery, seaworthiness, and mobility.

REFERENCES:

Armstrong, W.J., *Operation Sailor Hat, Technical Directors Report*, 30 January 1969, Naval Ship Engineering Center, POR-4068.

Preliminary Results of Operation Sailor Hat, Event Charlie, 30 April 1965, Bureau of Ships, D-2939/37.

SAILOR HAT DELTA

SERIES: Sailor Hat

LOCATION: Kahoolawe Island, Hawaii (20°30'26.71"N, 156°40'54.17"W), Eastern Shore, vicinity of Smuggler Cove.

DATE: 19 June 1965 at 1126 HST

CHARGE: 30,674 bare TNT blocks, each measuring 12" x 12" x 4" and weighing 32.98 lbs, were stacked on an octagonal concrete pad on the ground surface to form a hemisphere ∿34 ft in diameter.

WEIGHT (lb): 1,000,000

GEOLOGY: Volcanic rock 20 ft above sea level. Surface rock flow is light gray, slightly vesicular granular andesitic basalt. Underneath is a vesicular dark gray basalt. Clay zones existed in all drill holes.

METEOROLOGY: 7/10 cloud coverage over island, but GZ clear; wind direction 107° at 16 kts with gusts to 21 kts; air temperature 29.3°C; pressure 1014.5 mb; relative humidity 64%; air density 1.165 kg/m^3; visibility 10 miles.

TEST OBJECTIVE: Effects of high energy airblast loading and underwater shock on surface ships, particularly as to effects on weapon delivery, seaworthiness, and mobility.

REFERENCES:

Armstrong, W.J., *Operation Sailor Hat, Technical Director's Report*, 30 January 1969, Naval Ship Engineering Center, POR-4068.
Preliminary Results of Operation Sailor Hat, Event Delta, 9 July 1965, Bureau of Ships, D-3034/43.

SANDIA I
10 shots

SERIES: Sandia

LOCATION: Nevada Test Site, Area 10, Yucca Flat

DATE: December 1958 and January 1959

CHARGE: TNT. Spherical, centrally detonated. DOB: 6.35 to 25.40 ft. Stemming with dry sand.

WEIGHT (lb): 256 each

GEOLOGY: Desert alluvium composed of particles ranging from clay and silt to cobbles and boulders lightly cemented.

METEOROLOGY:

TEST OBJECTIVE: Obtain crater measurements in desert alluvium for a wide range of depths of burst. Establish optimum DOB for maximum apparent crater dimensions and determine at what DOB no apparent crater occurs.

REFERENCES:

Murphey, B.F. and H.R. MacDougall, *Crater Studies, Desert Alluvium*, May 1959, Sandia Corporation, SCTM 119-59(51).
Murphey, B.F., *High Explosive Crater Studies, Desert Alluvium*, May 1961, Sandia Corporation, SC-4614(RR).

SANDIA II
13 shots

SERIES: Sandia

LOCATION: Nevada Test Site, Area 10, Yucca Flat

DATE: August 1959

CHARGE: TNT. Spherical, centrally detonated. DOB 0.00 to 29.80 ft. Stemmed with tamped soil fill.

WEIGHT (lb): 256 each

GEOLOGY:

METEOROLOGY:

TEST OBJECTIVE: Obtain crater measurements in desert alluvium for a wide range of depths of burst. Establish optimum DOB for maximum apparent crater dimensions and determine at what DOB no apparent crater occurs.

REFERENCES:
Murphey, B.F., *High Explosive Crater Studies, Desert Alluvium*, May 1961, Sandia Corporation, SC-4614(RR).

SANDIA - TUFF
13 shots

SERIES: Sandia

LOCATION: Nevada Test Site, Area 14

DATE: April 1959

CHARGE: TNT. Spherical charge exploded at depths of 6.35 to 22.5 ft. Tamped with a few inches of sand above the charge, topped by concrete to the surface.

WEIGHT (lb): 256 each

GEOLOGY: Tuff

METEOROLOGY:

TEST OBJECTIVE: Provide HE data for comparison to results from nuclear explosives and for comparison to a similar series of explosions in desert alluvium.

REFERENCES:
Murphey, B.F., *High Explosive Crater Studies: Tuff*, April 1961, Sandia Corporation, SC-4574(RR).

SANDIA - COYOTE
10 shots

SERIES: Sandia

LOCATION: Coyote Test Field, Albuquerque, New Mexico

DATE: 1966

CHARGE: Spherical charges of cast TNT, centrally detonated. Four (1,2,6 and 8) were single-charge shots. Six were row shots of from two to five charges. Shots 6 through 10 were positioned in line with craters of shots 1 through 5, relating 1 and 6, 2 and 7, 3 and 8, 4 and 9, and 5 and 10; DOB 9.52 ft.

WEIGHT (lb): 256 each

GEOLOGY: Albuquerque alluvium.

METEOROLOGY:

TEST OBJECTIVE: Determine interaction of craters and ejecta under circumstances in which craters are formed adjacent to pre-existing craters.

REFERENCES:
Vortman, L.J., *Craters from Short-Row Charges and Their Interaction with Pre-Existing Craters*, July 1966, Sandia Corporation, SC-RR-66-324.

SERIES: Plowshare

LOCATION: Nevada Test Site, Area 18, Buckboard Mesa

DATE:

	A	B	C	D
February 1964	2/6	2/13	2/25	2/27

CHARGE: Nitromethane. Spherical, stemmed charges. DOB: Event A, 58 ft; Event B, 50.2 ft; Event C, 66.1 ft; Event D, 41.8 ft.

WEIGHT (lb): 40,000 each

GEOLOGY: A silty or sandy residual soil containing large fragments of vesicular basalt overlies a basalt cap ~200 ft thick.

METEOROLOGY:	Wind (mph)	Wind Direction	Sky Conditions	Radar Site Temperature (°C)
A:	13	280°	Clear	-3.5
B:	20	320°	1/10 Cu, 1/10 Sc	-1.4
C:	19	350°	4/10 Sc	1.7
D:	0	---	Clear	7.8

TEST OBJECTIVE: Obtain information on crater dimensions in hard, dry rock as a function of depth of burst and type of explosive for use in designing the Schooner nuclear cratering event; to develop a general cratering theory, and to improve prediction techniques.

REFERENCES:

Nugent, R.C. and D.C. Banks, *Pre-Shot Investigations for Project Pre-Schooner, Buckboard Mesa, Nevada Test Site*, September 1965, Army Engineer Waterways Experiment Station, AD 736 124.

Spruill, J.L. and R.A. Paul, *Project Pre-Schooner, Crater Measurements*, March 1965, PNE-502F.

pre-SCHOONER II

SERIES: Plowshare

LOCATION: Bruneau Plateau, Idaho

DATE: 30 September 1965 at 1709 MST

CHARGE: A single charge of liquid explosive nitromethane was emplaced at a depth of 71 ft in a lined spherical cavity ∿18 ft in diameter and stemmed with concrete. The charge was center-detonated by means of a booster charge of C-4 and SE-1 detonators.

WEIGHT (lb): 200,000

GEOLOGY: Hard, dry rhyolite rock

METEOROLOGY: Surface height 4715 MSL; wind 321°; pressure 862 mb; temperature 18.8°C.

TEST OBJECTIVE: Improve knowledge of crater dimensions as a function of depth of burst, type of explosive, and geology for use in emplacement design of the Schooner event. Included crater cloud development, and surface motion studies, and subsurface effects, ground shock, and airblast measurements.

REFERENCES:

Hughes, B.C., et al, *Project Pre-Schooner II, Technical Directors Summary Report*, October 1965, Army Engineer Nuclear Cratering Group, PNE-507.

Day, W.C. and R.F. Rohrer, *Project Pre-Schooner II, Cloud Development Studies, Final Report*, June 1966, Army Engineer Nuclear Cratering Group, PNE-511.

SCOOTER*

SERIES: Plowshare

LOCATION: Nevada Test Site, Area 10, Yucca Flat

DATE: 13 October 1960 at 0715 PST

CHARGE: TNT. Spherical stack centered 125 ft below the surface.

WEIGHT (lb): 1,000,000

GEOLOGY: Desert alluvium. Normal basin fill derived from arid region weathering of surrounding mountain ranges, composed of bedded and massive rhyolitic tuffs, dolomites, and some granite. Size ranges from fine rock flour to 1/2-ft cobbles.

METEOROLOGY: Temperature 10.2°C; wind 035° at 4 mph; ambient pressure 868 mb.

TEST OBJECTIVE: Provide technical and scientific information concerning the mechanics of crater formation by large underground chemical explosions and to relate craters produced by chemical and nuclear explosives. Included observations of ground motion, crater dimensions, throwout distribution, and a clarification of scaling laws.

REFERENCES:

Perret, W.E., et al, *Project Scooter Final Report*, October 1963, Sandia Corporation, SC-4602(RR).

*Note: Scooter-Cal, a 3000-lb calibration shot for Scooter, was fired in July 1960 at 14.5 DOB.

SHATTS

SERIES:

LOCATION: Pedernal Hills, near Willard, New Mexico

DATE: Information not available.

CHARGE: TNT.

WEIGHT (lb): 1,000

GEOLOGY: Highly-jointed granite outcrop.

METEOROLOGY:

TEST OBJECTIVE: Determine the lower limit of the cratering response of earth materials.

REFERENCES:

Lamping, Neal E., *"Recent Near-Surface High Explosive Cratering Experiments,"* in *Strategic Structure Vulnerability/Hardening Long Range Planning Meeting, 15-17 May, 1973*, DNA3132P-1, p 307.

SNOWBALL
(500-ton event)

SERIES: Suffield

LOCATION: Suffield, (SES) Watching Hills, Alberta, Canada

DATE: 17 July 1964 at 1058 MST

CHARGE: TNT. 30,678 blocks, each 12" x 12" x 4", arranged hemispherically with a radius of 17 feet; built on a 3-in. plywood base. Total weight: 1,000,200 ± 2000 lb DOB -6.4 ft.

WEIGHT (lb): 1,000,000

GEOLOGY: Glacially deposited silt, with underlying clay; sand, and gravel. Water-bearing lenses occurred at approximately 30 ft deep.

METEOROLOGY: Wind speed at 2 meters above surface averaged 5 mph from 245° true; humidity at 1 meter: 41%; atmospheric pressure 13.60 psi.

TEST OBJECTIVE: Develop and evaluate instrumentation and conduct basic blast, ground shock, electromagnetic, and debris distribution measurements, perform biomedical studies and assess underground target response, documenting all effects photographically.

REFERENCES:

Preliminary Report: Operation Snowball, October 1964, DASA Data Center (DASIAC), DASA 1550, SR 26-1.

A Preliminary Report on the British Participation in the 500-Ton Trial at Suffield in 1964, 30 October 1964, Ministry of Defence, London.

Rooke, A.D., Jr., et al, *Operation Snow Ball Project 3.1 Crater Measurements and Earth Media Determinations, the Apparent and True Craters*, April 1968, Army Engineer Waterways Experiment Station, Paper No. 1-987.

SOTRAN
5 shots

SERIES: Plowshare

LOCATION: White Sands Missile Range, Stallion and Oscura sites

DATE:	1	2	3	4	5
	10/29/65	11/3/65	6/9/66	6/15/66	6/15/67

CHARGE: Cast TNT. Hemispherical surface shots fired on separate alluvial fans.

WEIGHT (lb):	1	2	3	4	5
	20,000	20,000	40,000	40,000	100,000

GEOLOGY: Alluvium

METEOROLOGY:

TEST OBJECTIVE: Sources for an atmospheric sound transmission (SOTRAN) investigation. Crater dimensions were measured for comparison with other hemispherical-charge explosions. An M-113 armored personnel carrier containing dummies was exposed during a 20,000-lb shot and biomedical specimens (monkeys) were placed in an M-60 tank for the 9 June 1966 40,000-lb shot and the 15 June 1967 10,000-lb shot.

REFERENCES:

Vortman, L.J., *Craters in White Sands Alluvium from Surface-Burst Hemispheres*, December 1971, Sandia Laboratories, SC-RR-71-0864.

Long, Richard P., *Damage to an M60 Tank and Simulated Crew from Two 50-ton HE Detonations*, July 1970, BRL-MR-2643.

SSTV
4 shots

SERIES: SSTV (Diamond Mill) (Submarine Shock Test Vehicle)

LOCATION: Chesapeake Bay, Maryland

DATE: June 1970

CHARGE: HBX-1. Cylindrical, with a diameter to height ratio of 1:1. Positioned on the horizontal-perpendicular bisector of the longitudinal axis of the vehicle opposite the starboard side. The explosive charge was suspended underwater from a charge float. Depth of water was approximately 160 ft. Depth of SSTV and explosive was 75 ft.

WEIGHT (lb): 10,000 each

GEOLOGY:

METEOROLOGY:

TEST OBJECTIVE: Determine structural response of SSTV, shock environment, critical piping performance, shock performance of equipment, machinery, resiliently mounted units and shock vulnerability of communications transmission system and location aid device (LAD) transponder.

REFERENCES:

Wise, W.P., *Submarine Shock Test Vehicle (SSTV) Test Series 1(U)*, Naval Research and Development Center, Report TE-770-94, December 1970.

STAGECOACH I

SERIES: Plowshare

LOCATION: Nevada Test Site, Area 10

DATE: 15 March 1960 at 0900 PST

CHARGE: Blocks of TNT stacked spherically. Circumference 10 ft, DOB 80 ft.

WEIGHT (lb): 40,000

GEOLOGY: Desert alluvium

METEOROLOGY: Wind velocity 2 mph at 300°; temperature 5.3°C; relative humidity 34%; ambient pressure 875 mb; visibility unrestricted.

TEST OBJECTIVE: Verify and refine apparent departures from cube-root scaling. Tasks included blast geometry, seismic measurements, and throwout distribution, pressure measurements, and other cratering phenomena.

REFERENCES:

Vortman, L.J., et al, *20-Ton HE Cratering Experiments in Desert Alluvium, Project Stagecoach, Final Report*, May 1962, Sandia Corporation, SC-4596(RR).

SERIES: Plowshare

LOCATION: Nevada Test Site, Area 10

DATE: 19 March 1960 at 0800

CHARGE: Blocks of TNT stacked spherically. Circumference 10 ft. DOB 17.1 ft.

WEIGHT (lb): 40,000

GEOLOGY: Desert alluvium

METEOROLOGY: Wind velocity 10 mph at 40°; temperature 12.4°C; ambient pressure 872 mb; relative humidity 24%; visibility unrestricted.

TEST OBJECTIVE: Verify and refine apparent departure from cube-root scaling. Tasks included blast geometry, seismic measurements, and throwout distribution, pressure measurements, and other cratering phenomena.

REFERENCES:

Vortman, L.J., et al, *20-Ton HE Cratering Experiments in Desert Alluvium, Project Stagecoach, Final Report*, May 1962, Sandia Corporation, SC-4596(RR).

STAGECOACH III

SERIES: Plowshare

LOCATION: Nevada Test Site, Area 10

DATE: 25 March 1960

CHARGE: Blocks of TNT stacked spherically. Circumference 10 ft, DOB 34.2 ft.

WEIGHT (lb): 40,000

GEOLOGY: Desert alluvium

METEOROLOGY: Wind velocity 8 mph at 30°; temperature 14.2°C; ambient pressure 867 mb; relative humidity 35%; visibility unrestricted.

TEST OBJECTIVE: Verify and refine apparent departures from cube-root scaling. Tasks included blast geometry, seismic measurements, and throwout distribution, pressure measurements, and other cratering phenomena.

REFERENCES:

Vortman, L.J., et al., *20-Ton HE Cratering Experiments in Desert Alluvium, Project Stagecoach, Final Report*, May 1962, Sandia Corporation, SC-4596(RR).

SERIES: Sterling

LOCATION: Tatum Salt Dome near Hattiesburg, Mississippi (31°08'16.8"N,89°34'16.2"W).

DATE: 17 November 1966 at 0400 CST

CHARGE: Liquid nitromethane in a 99 x 244 cm circular cylinder at DOB of 831 meters in the Salmon shot-generated cavity.

WEIGHT (lb): 5,400 (TNT equivalent)

GEOLOGY: Salt dome with an overlay of anhydrite, sandstone, shale and clay.

METEOROLOGY:

TEST OBJECTIVE: Calibration shot to generate seismic signals equivalent to the decoupled Sterling nuclear explosion.

REFERENCES:

Springer, D. and M. Denny, " The Sterling Experiment; Decoupling of Seismic Waves by a Shot-Generated Cavity," in *Journal of Geophysical Research*, Vol 73, No. 18, 15 September 1968, pp 5995-6011.

Penet, W.R., "Seismic Source Energies of Four Explosions in a Salt Dome," in *Journal of Geophysical Research*, Vol 78, No. 32, 10 November 1973, pp 7717-7726.

SUFFIELD 5-TON
1959 series

SERIES: Suffield

LOCATION: Suffield Experimental Station, Watching Hill and Drowning Ford, Ralston, Alberta, Canada

DATE:

	1	2	3	4	5
1959	7/27	9/29	11/24	12/3	12/10
at MST:	1440	1233	1102	1406	1346

CHARGE: TNT. Hemispherical, made up of almost 300 12" x 12" x 4" cast TNT blocks weighing 33 lbs stacked around a central cube of TNT weighing ~325 lbs. The charge was built on a base of 1/4" plywood covered with a sheet of 20 gauge aluminum. The base was placed on lightly scraped ground.

WEIGHT (lb): 10,000 each

GEOLOGY: Watching Hill: extremely fine silt for 2 or 3 ft, underlain with sand. Drowning Ford: homogeneous clay-silt over a deposit of sharp fine sand.

METEOROLOGY:

Atmospheric pressure (psi)	13.57	13.66	13.51	13.69	13.57
Humidity (%)	30	61	79	51	57
Temperature °F	98.8	57.5	30.5	45.3	44.1
Wind/Velocity(ft/sec)	263°/3.4	105°/6.6	295°/2.5	260°/16.5	215°/4.3

TEST OBJECTIVE: Compare airblast effectiveness of ground burst cast TNT charges and those made up from a large number of carefully cast blocks of TNT detonated in contact with frozen and unfrozen prairie.

REFERENCES:

Groves, T.K., *Air Blast Peak Overpressures from 5-Ton TNT Ground Burst Hemispherical Charges (1959)*, 2 June 1961, Defence Research Board, Suffield Technical Paper 205.

SUFFIELD 20-TON
1960

SERIES: Suffield

LOCATION: Suffield Experimental Station, Ralston, Alberta, Canada
Watching Hill Blast Range

DATE: 18 August 1960 at 1000

CHARGE: TNT. Spherical, made up of 1218 stacked 12" x 12" x 4" blocks each weighing 32.5 lbs; tetryol booster and two detonators. Charge was built on 2-3/4 layers of plywood 12-ft square, placed on bare ground. Radius of 69.5 in.

WEIGHT (lb): 40,000

GEOLOGY: Extremely fine silt for the first 2 to 3 ft, underlain with free-running sand to a depth of about 12 ft.

METEOROLOGY: Atmospheric pressure 13.54 psi; relative humidity 32%; wind direction, west to east toward GZ/ wind velocity 4.94 ft/sec; clear sky, bright sunshine; temperature 98.7°F.

TEST OBJECTIVE: Measure blast effects, including outgoing shock and blast waves and various ground effects.

REFERENCES:
Scientific Observations on the Explosion of a 20-Ton TNT Charge, General Information and Measurements, 1 September 1961, Defence Research Board, Suffield Report No. 203.

SUFFIELD 100-TON
August 1961

SERIES: Suffield

LOCATION: Suffield Experimental Station, Ralston, Alberta, Canada

DATE: 3 August 1961 at 1030 MST

CHARGE: TNT. Hemispherical stack of 6140 12" x 12" x 4" blocks. Radius, 9.92 ft. Charge was built on 3/4" layers of plywood placed on bare, level and tamped ground overlaid with 2" of sand.

WEIGHT (lb): 200,000

GEOLOGY: Light colored, inorganic silty clay, medium plasticity. From depth of 50 to 200 ft is solid blue clay.

METEOROLOGY: Surface temperature 130°F; wind at 095° at 3.5 mph; atmospheric pressure 13.67 psi; relative humidity 21%; bright sunshine.

TEST OBJECTIVE: One of a series of programs to measure blast and shock effects from a few pounds through 200,000 lbs of TNT. Involved Canadian, U.S. and British projects. Numerous structures and vehicles were exposed.

REFERENCES:

Smale, W.R. and R.C. Sigs, *Surface Burst of 100 tons TNT Hemispherical Charge, Project, Field Data and Some Preliminary Canadian Results*, January 1962, Suffield Experimental Station, SES No. 205.

Preliminary Report United States Participation in 1961 Canadian 100-Ton High-Explosive Test, 1 September 1961, Defense Atomic Support Agency, DASA-1249.

SUFFIELD 5-TON
August 1963

SERIES: Suffield

LOCATION: Suffield Experimental Station, Ralston, Alberta, Canada

DATE: 2 August 1963 at 1348 MST

CHARGE: 310 TNT blocks, each 12" x 12" x 4" and having a weight of 32.68 lbs, stacked spherically on the ground surface.

WEIGHT (lb): 10,000

GEOLOGY: Top 10 to 12 ft reasonably homogeneous clay-silt lying over a deposit of sharp fine sand almost free of silt.

METEOROLOGY:

TEST OBJECTIVE: Test equipment and methods for obtaining information for a planned 1,000,000-lb TNT surface detonation.

REFERENCES:

Diehl, C.H.H., et al, *Cratering and Displacement Data for Three Surface Burst TNT Trials at SES (1963)*, 5 March 1965, Defence Research Board, Technical Paper 301.

SUFFIELD 20-TON
1963

SERIES: Suffield

LOCATION: Suffield Experimental Station, Ralston, Alberta, Canada; Drowning Ford Blast Range.

DATE: 15 August 1963 at 1050 MST

CHARGE: 1218 blocks of TNT, each 12" x 12" x 4" and weighing ~32.5 lbs, stacked spherically on plywood panels at ground level.

WEIGHT (lb): 40,000

GEOLOGY: Brown Lacustrine deposit of nearly pure silt and clay. Vegetation consists of prairie grass, small cacti, and low shrubs. At detonation ground zero the silt surface was bare.

METEOROLOGY: Surface temperature 25°C; wind 290° at 10 mph; relative humidity 52%; atmospheric pressure 13.63 psi.

TEST OBJECTIVE: Measure blast and shock effects.

REFERENCES:

Nosworthy, C.T. and C.D. Miller, *Multisensor Aerial Reconnaissance of a 20-Ton High Explosive Surface Detonation*, 1 June 1965, U.S. Naval Radiobiological Defense Laboratory, USN RDL-TR-862.

Diehl, C.H.H., et al, *Cratering, Ejecta and Displacement Data for a 40,000 lb TNT Surface Burst Charge (1963)*, 12 November 1964, Defence Research Board Suffield, TP No. 300.

SUFFIELD 5-TON
September 1963

SERIES: Suffield

LOCATION: Suffield Experimental Station, Ralston, Alberta, Canada; Drowning Ford Range

DATE: 18 September 1963 at 1315 MST

CHARGE: Blocks of TNT stacked spherically, resting on ground surface.

WEIGHT (lb): 10,000

GEOLOGY:

METEOROLOGY:

TEST OBJECTIVE: Test equipment and methods for obtaining information for a planned 1,000,000-lb TNT surface detonation.

REFERENCES:

Diehl, C.H.H., et al, *Cratering and Displacement Data for Three Surface Burst TNT Trials at SES (1963)*, 5 March 1965, Defence Research Board, Technical Paper 301.

SUFFIELD 1965
Field Experiment 561
4 shots

SERIES: Suffield

LOCATION: Suffield Experimental Station, Ralston, Alberta, Canada

DATE:	1	2	3	4
	19 Aug 1965	24 Sept 1965	7 Oct 1975	19 Oct 1965
	1100	1100	1045	1500

CHARGE: 1. Block built TNT hemispherical charge. 2. Cast TNT spherical charge half buried. 3. Block built TNT spherical charge mounted on a tower with the center of the charge at a height of 25 ft. 4. A 32-ft diameter balloon containing a mixture of methane and oxygen detonated with the center of the balloon about 25 ft above the ground.

WEIGHT (lb): 1,2,3: 1,000
4: 2,000

GEOLOGY:

METEOROLOGY:

	Atmospheric Pressure (psi)	Air Temperature °F	Wind Speed and Direction at 2 meters		at 4 meters	
			mph	°T	mph	°T
1:	13.46	82.2	8.0	200	9.0	200
2:	13.36	66.2	9.7	280	12.0	280
3:	13.43	57.7	3.3	280	3.4	280
4:	13.45	53.0	1.1	335	1.3	335

TEST OBJECTIVE: Three TNT trials were designed to investigate the suitability of an elevated TNT charge for the Distant Plain trials planned for 1966 and 1967, and to compare the airblast, cratering, and seismic effects of a hemispherical charge on the surface and a spherical charge buried with its center at the ground-air interface. The balloon test was to determine the feasibility of using 110-ft diameter balloon in the Distant Plain events.

REFERENCES:

Patterson, A.M., *Trail Report of the 1000 lb Trials Carried Out During 1965-Field Experiment No. 561*, May 1971, Defence Research Establishment, Suffield, No. 283.
Diehl, C.H.H., *Crater Ejecta and Displacement Data from Explosions of 1000 lb TNT Charges*, 12 October 1967, Defence Research Establishment Suffield, No. 200.

Note: A fifth test failed.

TOBOGGAN
98 shots

SERIES: Plowshare

LOCATION: Nevada Test Site, Yucca Flat

DATE: 30 October 1959 to 3 June 1960

CHARGE: TNT or PETN. Linear or spherical 6 charges in row with 12.7-ft spacing. 0.23 to 42.7-lb per ft. All charges were end detonated in Phase I. Phase II were multi-detonated. Phase 1 scaled DOB ($ft/w^{1/2}$) ranged from 0.0 to 2.0; Phase II ranged from 0.0 to 3.0.

WEIGHT (lb): 5 rows: 8-lb charges - spherical
1 row: 256-lb charges - linear

GEOLOGY: Compact fine silt and clay that is extremely uniform both laterally and vertically.

METEOROLOGY:

TEST OBJECTIVE: Explosive ditching experiments.

REFERENCES:
Vortman, L.J., *Explosive Cratering Experiments*, May 1961, Sandia Corporation, SCR-406.
Carlson, R.H., *Project Toboggan High Explosive Ditching from Linear Charges*, July 1961, SC-4483(RR).

TONOPAH
36 shots; 12 arrays
of 4 shots each

SERIES: Plowshare

LOCATION: Tonopah Test Range, Nevada (Cactus Flat)

DATE: 12 May 1964 to 27 March 1967

CHARGE: Cast TNT. Spherical. Each charge about 13 in. in diameter, was placed in a 16-in. diameter drilled hole. Holes were backfilled with material drilled from the hole and subsequently moistened for compaction to maximum density. In each shot all four charges were detonated simultaneously. DOB to charge center varied from 0 to 12 ft. Center to center spacing of charges varied from 2 to 18 ft.

WEIGHT (lb): 256 (four 64-lb charges in one array)

GEOLOGY: Dry lake playa of silty clay or clayey silt.

METEOROLOGY:

TEST OBJECTIVE: Determine whether an array of four equally spaced charges in a square array is as effective as a single larger charge.

REFERENCES:
Vortman, L.J., *Airblast and Craters from Rows of Two to Twenty-Five Buried HE Charges*, January 1969, Sandia Corporation, SC-RR-68-655.
Vortman, L.J., *Craters from Four Equal Charges in a Horizontal Square Array*, March 1965, Sandia Corporation, SC-RR-65-6.

TONOPAH
16 shots

SERIES: Plowshare

LOCATION: Tonopah Test Range, Nevada

DATE: 26 August 1965 to 3 November 1966

CHARGE: Five 64-lb cast spheres for 15 shots; five 256-lb spheres for 1 shot. All arranged in horizontal square array and embedded at burial depths of 6,8 or 10 ft and at different spacings.

WEIGHT (lb): 320 for 15 shots
1,280 for 1 shot

GEOLOGY: Dry lake playa of silty clay or clayey silt at an elevation of 5362 ft.

METEOROLOGY: In all events, wind was calm. Temperature varied from 40°F to 81°F. Pressure varied from 832.2 to 842.2 mb.

TEST OBJECTIVE: Determine the effect of five equal high-explosive charges placed in a square array for comparison with equal single charges detonated at the same depth.

REFERENCES:
Rappleyea, C.A., *Crater Ejecta, and Air-Blast Studies from Five High-Explosive Charges in a Horizontal Square Array*, April 1967, Sandia Corporation, SC-RR-66-480.

TONOPAH

SERIES: Sandia

LOCATION: Tonopah Test Range, Cactus Flat, Southeast of Tonopah, Nevada

DATE: 5 October 1966 to 27 March 1967

CHARGE: TNT. DOB 6.0 - 6.9 ft; spaced 5.25 - 8.00 ft; from 2 to 25 charge rows.

WEIGHT (lb): 64 each charge (128 lb to 1,600 lb each row)

GEOLOGY: Dry lake bed (playa)

METEOROLOGY:

TEST OBJECTIVE: Determine seismic disturbances and airblast effects of row charges.

REFERENCES:

Vortman, L.J., *Airblast and Craters from Rows of Two to Twenty-five Buried HE Charges*, January 1969, Sandia Laboratories, SC-RR-68-655.

TRINIDAD B
8 shots

SERIES: Plowshare

LOCATION: Trinidad, Colorado

DATE: 10 August 1971 through 13 August 1971
at times from 0835 to 1440

CHARGE: B-1 through B-3, ANFO; B-4 through B-8, AANS (aluminized ammonium nitrate slurry). Emplaced in 2-ft diameter holes; stemmed with a mixture of drill cuttings, 3/4-in. aggregate, and water. DOB varied from 15.2 to 28.1 ft.

WEIGHT (lb): 2,000 each

GEOLOGY: *Interbedded sandstones and shales (Vermejo formation of Late Cretaceous age).* Overburden consists of very clayey soil varying from 0 to 15 ft in the test area.

METEOROLOGY: *Temperature ranges from 32° to 90°F; winds, various; ambient pressure,* 810 mb.

TEST OBJECTIVE: Investigate the fundamentals of cratering and the economic aspects of explosive excavation. Obtain optimum crater dimensions and depth of burst as a design base for follow-on row charge experiments. Compare results of ANFO and AANS.

REFERENCES:

Redpath, Bruce B., *Project Trinidad Explosive Excavation Tests in Sandstone and Shale*, July 1972, Army Engineer Waterways Experiment Station, TR E-73-1.
Vortman, L.J., *Airblast from Project Trinidad Detonations*, June 1971, Sandia Laboratories, SC-RR-71-0056.

TRINIDAD C
6 row-charge detonations

SERIES: Plowshare

LOCATION: Trinidad, Colorado

DATE:

	C1	C2	C3	C4	C5	C6
1971	9/28	9/29	10/1	10/1	10/2	9/30
MST	1000	1000	0910	1500	1000	1000

CHARGE: AANS (aluminized ammonium nitrate slurry) in row-charge detonations. Emplaced in 3-ft diameter holes; stemmed with pit-run gravel, a small amount of drill cuttings and water. Five to 7 charges were detonated simultaneously in 3 rows; a millisecond delay was introduced between 5 charges in 2 rows; 5 double-row charges 39 ft apart were detonated simulateously in one event. DOBs varied from 17.3 to 23.6 ft.

WEIGHT (lb): 2,000 each

GEOLOGY: Interbedded sandstones and shales (Vermejo formation of Late Cretaceous age). Overburden consists of very clayey soil varying from 0 to 15 ft in the test area.

METEOROLOGY: Ambient pressure: 810 mb.

TEST OBJECTIVE: C1 to C3 determined relationship between row crater enhancement and charge spacing in sandstone. C4 and C5 observed reduction of airblast, ground shock and crater size resulting from delayed detonations. C6 gave design information about double row charges.

REFERENCES:
Redpath, Bruce B., *Project Trinidad Explosive Excavation Tests in Sandstone and Shale*, July 1972, Army Engineer Waterways Experiment Station, TR E-73-1.
Vortman, L.J., *Airblast from Project Trinidad Detonations*, June 1971, Sandia Laboratories, SC-RR-71-0056.

TRINIDAD D
4 row charge detonations

SERIES: Plowshare

LOCATION: Trinidad, Colorado

DATE:

	D1	D2	D3	D4
1970	11/17	11/18	11/19	12/16
MST	1115	1030	1015	1115

CHARGE:

D1-ANFO	D2-AANS	D3-AANS	D4-AANS
11.5 - 23.7 ft	17.5 - 17.8 ft	18.7 - 25.0 ft	16.9 - 25.2 ft

Emplacement in drilled holes.

WEIGHT (lb):

D1	D2	D3	D4
9, 200-2,000	5, 2,000	5, 4,000; 6, 2,000	20, 2,000; 12, 4,000

GEOLOGY: Non-level terrain; interbedded sandstone and shale medium with 5 to 10 ft of overburden.

METEOROLOGY: Temperature 45° to 51°; clear; wind 0 to 5 mph. Ambient pressure 810 mb.

TEST OBJECTIVE: Provide opportunity to experiment with row charges in non-level terrain. D1 was designed to cut a channel with a constant bottom elevation through a ridge-like topography. D2 with a single row of charges and D3 with a double row of charges, attempted hillside cuts. D4 was a sequentially fired double row to excavate a 400-ft railroad cut.

REFERENCES:

Redpath, Bruce B., *Project Trinidad Explosive Excavation Tests in Sandstone and Shale*, July 1972, Army Engineer Waterways Experiment Station, TR E-73-1.
Vortman, L.J., *Airblast from Project Trinidad Detonations*, June 1971, Sandia Laboratories, SC-PR-71-0056.

TRINITY HE

SERIES: Trinity

LOCATION: Alamogordo, New Mexico

DATE: 7 May 1945

CHARGE: TNT and Composition B.

WEIGHT (lb): 216,000

GEOLOGY: Dry sand

METEOROLOGY: Surface winds 3-5 mph; visibility unlimited; temperature 50°F.

TEST OBJECTIVE: Calibration test preceding the first nuclear explosion.

REFERENCES:

Vol 24 Trinity, Results of Measurements, Appendices 63 through 71, 9 October 1947, LA-1027.

TUGBOAT PHASE 1
5 shots
(Safety Calibration
Series)

SERIES: Plowshare

LOCATION: Kawaihae Bay, Hawaii

DATE:		1A	1B	1C	1D	1E
	1969	11/6	11/6	11/4	11/5	11/7
	at	0901	1101	1001	0901	1101

CHARGE: Aluminized ammonium nitrate slurry (AANS).

DOB below water surface (ft)	1A	1B	1C	1D	1E
	17.33	17.86	21.72	25.84	42.9

Charge cannisters placed in drill holes.

WEIGHT (lb)	1A	1B	1C	1D	1E	
	2,000	2,000	1,975	1,950	20,000	(TNT Equivalent)

GEOLOGY: Submerged coral limestone.

METEOROLOGY:

Wind direction and velocity (ft/sec)	1A	1B	1C	1D	1E
	ESE 29	ESE 23.5	ESE 37	ESE 29	ESE 22

TEST OBJECTIVE: Provide air-overpressure effects data, as functions of distance and charge weight, for a safety evaluation of proposed large-yield detonations for the berthing basin and an entrance channel for a small-boat harbor. Principal objective was to provide data useful in the development of both chemical and nuclear excavation technology for harbors.

REFERENCES:

Vortman, L.J., *Airblast from Project Tugboat Detonations*, November 1970, Sandia Laboratories, SC-RR-70-541.

Day, Walter C., *Project Tugboat Explosive Excavation of a Harbor in Coral*, February 1972, Army Engineer Waterways Experiment Station, TR E-72-23.

TUGBOAT PHASE II
3 shots

SERIES: Plowshare

LOCATION: Kawaihae Bay, Hawaii

DATE:	2A	2B	2C
	4/23/70	4/28/70	5/01/70

CHARGE: Four 10-ton charges of aluminized ammonium nitrate slurry (AANS) for each of three events. The first included 4 charges spaced 100 ft apart in linear array and detonated simultaneously. For the second, charges were spaced 120 ft apart in a nearly linear array and were detonated in sequence with 0.1 second delay between detonations. In the third event the charges were in a sqaure array with 120 ft between charges. Burial depth of all charges was approximately 42 ft.

WEIGHT (lb): 80,000 each (TNT equivalent)

GEOLOGY: Submerged coral limestone.

METEOROLOGY:

	2A	2B	2C
Wind direction and velocity (ft/sec)	SSE 4-9	NWS 7-10	W 9-10

TEST OBJECTIVE: Document airblast in the event of damage claims, and provide a better understanding of airblast from rows and arrays of charges. The major purpose of the explosions was to provide an entrance channel for a small-boat harbor and to excavate the berthing basin.

REFERENCES:

Vortman, L.J., *Airblast from Project Tugboat Detonations*, November 1970, Sandia Laboratories, SC-RR-70-541.
Day, Walter C., *Project Tugboat Explosive Excavation of a Harbor in Coral*, February 1972, Army Engineer Waterways Experiment Station, TR E-72-23.

TUMBLER HE
48 shots

SERIES: Tumbler

LOCATION: Coyote Canyon, New Mexico (Sandia Corporation Test Site)

DATE: 4 February 1952 through 2 January 1953

CHARGE: TNT. Spherical, 20-1/4 in. diameter. HOB varied from half-buried to 100 ft. For surface bursts, sphere was placed in a wooden stand so that the only point of contact of the sphere with the ground was GZ. For the half-buried charge a pit of one charge radius placed the center of the charge at GZ. Above-ground bursts were hoisted in a canvas sling.

WEIGHT (lb): 250 each

GEOLOGY:

METEOROLOGY: Barometric pressure varied from 24.00 to 25.97; humidity ranged from 7% to 76%; temperature ranged from 38° to 81°F; wind velocity 0 to 20 mph.

TEST OBJECTIVE: Assist in resolving height-of-burst pressure/distance/time relationships.

REFERENCES:
Shreve, J.D., Jr., *Operation Tumbler, Pressure-Distance-Height Study of 250-lb TNT Spheres*, 13 March 1953, Sandia Corporation, WT-520.

UET 68 ROUNDS (DUGWAY)
(also see next page)

SERIES: Underground Explosion Test Program*

LOCATION: Dugway Proving Ground, Utah
Unaweep Canyon, Colorado
Buckhorn, Washington

DATE: 5 May 1951 - 13 November 1951

CHARGE: TNT.

WEIGHT (lb):

110 lb = 1 round	10,000 lb = 1 round
320 lb = 44 rounds	40,000 lb = 5 rounds
1,000 lb = 1 round	320,000 lb = 2 rounds
2,560 lb = 14 rounds	

GEOLOGY: Dry and wet clay, sandstone, limestone, granite.

METEOROLOGY:

TEST OBJECTIVE: To study the generation and propagation of explosive waves from underground detonations and the effects of these waves on underground structures. To compare cratering in dry sand, dry clay, wet clay, limestone, granite, and sandstone.

REFERENCES:
Underground Explosion Test Program, Final Report, Vol 1, Soil, 20 August 1952, Engineering Research Associates, Inc. ERA-1.

*Included 68 scheduled detonations of more than 100 lb.

UET DUGWAY
3 rounds

SERIES: UETP (Underground Explosion Test Program)

LOCATION: Dugway Proving Ground, White Sage Flat, Utah

DATE: 5, 10 and 22 May 1951

CHARGE: Cast TNT blocks arranged spherically.

Round	3/12	3/15	3/18
	5/5	5/10	5/22
	DOB - 7 ft	DOB - 17 ft	DOB - 35 ft

WEIGHT: (lb)	5/5	5/10	5/10
	2,560	40,000	320,000

GEOLOGY: *Dry clay soil with minor amounts of interbedded fine sand, silt and diatomaceous marl.* The overburden is an unstratified mixture of silt and clay containing a small amount of humus. No water table.

METEOROLOGY:

TEST OBJECTIVE: Determine the response of surface and underground structures subjected to underground explosions to develop protective construction criteria.

REFERENCES:

Vaile, R.B., Jr., *Underground Explosions at Dugway, Surface Structure Program, Final Report*, March 1952, Stanford Research Institute, AF SWP-295, AD 894600L.
Underground Explosion Tests, Final Report, Supplementary Skew Structures Program, June 1953, Chief of Engineers, Department of the Army, AFSWP-126.

WES-BIG BLACK RIVER
Shot 26

SERIES: WES

LOCATION: Waterway Experiment Station, Big Black River Test Site, Vicksburg, Mississippi

DATE: March 1955 to December 1956

CHARGE: Precast TNT spheres with 18-1/2 in. diameter placed on 30 x 30 x 4 ft concrete slab on river sand.

WEIGHT (lb): 256 each

GEOLOGY: 1.56 ft of dry to moist river sand.

METEOROLOGY:

TEST OBJECTIVE: Determine the effects of a soil-rock interface on cratering phenomena and the effects of the interface on ground shock.

REFERENCES:
Effects of a Soil-Rock Interface on Cratering, May 1958, Army Engineer Waterways Experiment Station, AFSWP-1056.

WES-LOTS*
Shots D,E,F
140 charges

SERIES: WES

LOCATION: Lake Ouachita-Blakely Mountain Reservoir (20 miles West of Hot Springs, Arkansas)

DATE: October and November 1961, 1962 1963

CHARGE: D: 125-lb sphere TNT; E: 385-lb hexoctahedron TNT; F: 800-lb C4 cylinder. Charge depths ranged from +0.50 to -36.50 ft.

WEIGHT: (lb)	D	E	F
	98 135-lb	41 385-lb	1 800-lb C4 (≈ 1,000-lb TNT)

GEOLOGY: Water depths ranging from 70 to 110 ft.

METEOROLOGY:

TEST OBJECTIVE: Determine effect of depth of explosion, resulting wave generation phenomena and wave dimensions, critical depth of charge for optimum coupling of energy into waves, and analyze the propagation characteristics.

REFERENCES:
Pinkston, J.M., Jr., *Surface Waves Resulting from Explosions in Deep Water, Summary of Experimental Procedures and Results of Tests at Lake Ouachita, Arkansas*, April 1966, Army Engineer Waterways Experiment Station, DASA 1482-2.

Note: A,B, and C of the series were charges under 100 lb.

WES
Mississippi River

SERIES: WES

LOCATION: Mississippi River near Diamond Cut-off, 10 miles south of Vicksburg

DATE: 1952

CHARGE: Four 256-lb TNT charges were spherically shaped. One 600-lb charge and one 2048-lb charge were cube shape, made up of 100-lb blocks of cast TNT and 1-lb demolition blocks. Charge positions at bottom and at mid-depth.

WEIGHT (lb): 256; 600; 2,048.

GEOLOGY: Deep deposits of sand in the form of long flat bars along the river bed.

METEOROLOGY:

TEST OBJECTIVE: Determine by means of small-scale TNT charges the magnitudes of the various effects of a 20-kt nuclear explosion in water depths typical of harbor areas. Establish scaling principles for various explosive effects. Include cratering, water-surface waves, airblast, water shock, and ground shock.

REFERENCES:
Effects of Explosions in Shallow Water, Cratering Effects in Sand, Surface Waves, and Airblast Measurements for a Scaled Water Depth of 200 ft., Waterways Experiment Station, April 1853, AFSWP 135.
Effects of Explosions in Shallow Water, Final Report, Waterways Experiment Station, April 1955, AFSWP-452.

WES 106-1b POND PROGRAM
14 charges

SERIES: WES

LOCATION: Waterways Experiment Station, Vicksburg, Mississippi

DATE: Not given.

CHARGE: Non-vacuum cast spheres of HBX-1, 15-in. diameter. Burst depths of 1.45 ft and 3.44 ft.

WEIGHT (lb): 106 each

GEOLOGY: The WES pond is a rectangular excavation 300 ft long, 150 ft wide, and 20 ft deep.

METEOROLOGY:

TEST OBJECTIVE: Obtain airblast and surface data from HBX-1 spheres, fired in deep water at shallow burst depths to check for scaling with data from other HBX-1 and various high explosive tests.

REFERENCES:
Pittman, J.F., *Airblast From Shallow Underwater HBX-1 Explosions*, 3 April 1968, Naval Ordnance Laboratory, NOLTR 68-45.

WES 109-1b POTOMAC RIVER PROGRAM
12 charges

SERIES: WES

LOCATION: Potomac River, off NOL's Stump Neck Facility

DATE: Not given.

CHARGE: Non-vacuum cast HBX-1 spheres centrally boosted. Twelve charges were fired in the bottom at 3.47 ft, and 12 were fired mid-depth in 2.93 ft of water.

WEIGHT (lb): 109 each

GEOLOGY: Bottom material was an aggregate of gravel and silt. Aggregate ranged from fine sand to 3-in. diameter rocks.

METEOROLOGY:

TEST OBJECTIVE: Determine the effect of the bottom on airblast generation.

REFERENCES:
Pittman, J.E., *Airblast from Shallow Underwater HBX-1 Explosions*, 3 April 1968, Naval Ordnance Laboratory, NOLTR 68-45.

SERIES: White Tribe (White Sands Triple Burst Experiment)

LOCATION: White Sands Missile Range, New Mexico

DATE:		I	II	III
	1961	6 April	27 April	28 May
	at	1015	1011	1012

CHARGE: Each of the three separate shots was made up of three 11,560-lb TNT charges arranged at the apexes of an equilateral triangle, 176 ft on each side. The individual charges were made up from 8-lb blocks of TNT stacked to simulate a hemisphere (convex upward) on the ground surface.

WEIGHT (lb): 34,680 each

GEOLOGY: Soil is loose, fine-grained silica with some gypsum sand. A firm caliche layer exists just beneath the surface material.

METEOROLOGY:		I	II	III
	Winds:	14°, 7 kts	Calm	90°, 8 kts

TEST OBJECTIVE: Study blast wave phenomena from multiple simultaneously detonated high explosive charges.

REFERENCES:

Armendt, B.F., *Project White Tribe: Air Blast from Simultaneously Detonated Large Scale Explosive Charges*, September 1961, Ballistic Research Laboratories, BRL 1145.

Carlson, Roland H., et al, *Local Distribution of Material Ejected by Surface Explosions: White Tribe Interim Report*, August 1961, Boeing Airplane Company, D2-6955-2.

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